AN ENLISTED SEA/SHORE ROTATION MODEL

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THESIS

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ABSTRACT

The Enlisted Sea/Shore Rotation Model presents a methodology for the orderly reassignment of U. S. Navy enlisted personnel between the sea and shore communities. The model is flexible enough to evaluate a number of rotation policy operations within the context of published constraints on tour lengths and manning levels.

The primary objective is to propose alternate methods for sea/shore rotation management based on fixed tour lengths which will reduce the uncertainty of a rotation date to the individual. This was accomplished by assigning a firm projected rotation quarter (PRQ), and then modifying it to a specific month of rotation (MOR) within the PRQ, by notification, nine months prior to rotation.

Auxiliary solutions were also evaluated which augmented the present billet structure to achieve specified manning criteria.

TABLE OF CONTENTS

LIST OF FIGURES

I. INTRODUCTION

A. BACKGROUND

In order to maintain a broad experience base within the Navy's enlisted component, it has become necessary to rotate personnel on a periodic basis between the various duty assignments peculiar to a rating. The career development achieved by varied duty patterns is sound from both the individual's and the Navy's point of view. Each of the ratings has a unique set of skills associated with it. These skills partially determine to what extent the rating is needed at sea or ashore. Skills particularly germane to shipboard operations will find a greater requirement for that rating at sea. The measure of skill requirement has typically been the billet structure.

Optimally filling the billet structure with the given strength profile of a rating is the primary objective of most rotation planning devices in use today. As this is undertaken, the manning level (strength-to-billet ratio) of the composite is usually cited as a measure of the effectiveness in filling the billet structure. Often the ideal solution results in relatively long prescribed tour lengths either at sea or ashore depending on the rating's billet structure. When, for example, it becomes necessary to limit the tour at sea or provide compensatory billets ashore, the manning levels will likely undergo change. Since gross

changes in the strength distribution are usually not immediately feasible, the maintenance of balanced manning levels is obtained by utilizing a sliding tour length.

The rotation process today is an outgrowth of a survey system implemented for operational use in November, 1967. Basically this system surveyed a duty category for projected vacancies and set "cut-off dates" which represented the eligibility criteria to rotate. For example, in the sea community, the sea duty commencement date (SDCD) was used as a cut-off date. This allowed personnel with a SDCD on or before the cut-off to submit requests for reassignment in the next shore survey (SHORVEY). The system had several deficiencies, not the least of which was the coordination of the various surveys (SEAVEY, SHORVEY, NEUVEY, and OSVEY) within the Navy's rotation system.

From the survey technique came the process of assigning tour lengths which contracted and expanded to meet the manning requirements. The variable tour concept of "toured sea duty" and "toured shore duty" is now used to control eligibility for rotation between the sea and shore communities.

B. THE PROBLEM

In this author's opinion, the adjustable tour length system has two serious shortcomings. First, the uncertainty of a rotation date disrupts the individual's plans. Without a credible projected rotation date (PRD), the parent command is hesitant to plan for the individual's relief. In the

context of shipboard deployments, where crew stability is critical, the unknown factors of losses and gains are serious problems. To the individual, the impact of this uncertainty may well have an influence on career retention.

The second drawback of variable tour length rotation is that it results in suboptimization of the forces which operate on aggregate billet manning. Promotion is one tool used to change strength levels within a given composite. Accessions to the rating, through technical schools, rate conversion or normal on-the-job training of apprentice inputs, represent another means for strength manipulations. If the tour lengths are varied to move strength quotas, the promotion and accession phenomenon will often appear to be haphazard in their attempts to regulate manning distributions. A variable tour policy mitigates the coordinated effort of promotion and accession to control strengths within the composites. A secondary effect of changing a specific PRD is that the results are not confined to the composite undergoing the change. For example, lengthening the sea tours for E-5 radiomen may well result in future change requirements for E-6 radiomen, both at sea and ashore. The low credibility of published PRDs contributes to the fact that there is little restraint exercised in using the PRD to counter short-term manning crises.

It is realized that the above assessment represents an oversimplification of an extremely complex system. The

actual detailing process incorporates many safeguards and temporary fixes such as the practice of manning a billet requiring a specified paygrade with personnel from an adjacent paygrade as the need dictates. Additionally, special pre-deployment rules are designed to maintain crew stability. Also, there is a 12-month lockout whereby PRD changes are discouraged after the one-year point prior to rotation. In the face of continual billet changes, it is only through careful attention to detail that strengths even remotely resemble billet requirements for the composites.

Thus, the existing rotation system gains its flexibility to control the composite size at the expense of the career sailor, by adjusting his rotation date. The floating tour lengths impair the effectiveness of promotion and accessions in meeting manning balance.

C. RELATED STUDIES

This section will give a brief overview of the present state of rotation management with reference to two different models now used to predict tour lengths.

The first such model is an analytical planning device developed by the Naval Personnel and Training Research Laboratory and discussed in Refs. 1 and 2. The model basically equates the demand for vacated shore billets by the rotatable sea composite to the supply of these billets ashore and calculates an equilibrium sea tour. The

maintenance of the dynamic equilibrium achieved by the model necessitated changes in the sea tour lengths to keep apace of the policy instituted changes in promotion, billets and attrition.

The second model, developed by PERS N12, was an operational tool used to investigate the impact of policy change on the existing sea/shore rotation system. The ATLAS tour simulator was a simulation utilizing BUPERS supplied parameters, such as promotion, attrition, billet and strength profiles, and initial sea and shore tour lengths. Improved tour lengths for the E-5/E-6 and E-7/E-9 communities subject to manning criteria were the outputs of this model. The simulation was run for eight years with the inputs to the E-5/E-6 composites empirically derived from past data. The model often suggested major changes in existing tour lengths in order to meet even manning over the period of the simulation.

II. PROBLEM FORMULATION

A. MODEL OBJECTIVE

The objective of the Enlisted Sea/Shore Rotation Model is to evaluate policies that are based on fixed tour lengths. For the policies under investigation, the enlisted man would receive a projected rotation quarter (PRQ) upon arrival to the composite that would remain fixed for the duration of his stay in the composite. It is intended that tour length *per se*, cease to be a control variable in achieving balanced manning.

B. PROCEDURES

The quarterly cohort can be thought of as those individuals in a composite with the same PRQ, e.g., fourth quarter fiscal year 1977. As the quarterly cohort progressed through the simulation toward its eventual rotation, the size was modified by the forces of attrition and promotion. When the cohort reached its rotation quarter, it was divided into three monthly segments. For a "uniform" detailing policy, the monthly segments were simply one-third of the quarterly cohort. The final policy investigated the use of a "proportional" or detailing guidance methodology, whereby the monthly segments were proportioned in a manner that reduced the manning level difference between the sea and shore composites.

Two auxiliary policy applications entailed modifications to the billet structures to achieve equal manning in each of the paygrade composites. This was accomplished by billet augmentations to either the sea or shore communities. These policies represent only half solutions to manning level imbalances since they simply create or destroy billets without regard for the billet requirements or the strength changes necessary to fill them. The creation of requirements and the building of strengths are longer term undertakings.

The model was used to investigate four basic touring schemes but is not limited to these applications. The policies tested are as follows:

RUN 1. Three-Year Tours. Since there is a strong equity argument for tours of the same length whether at sea or ashore, this application served as a starting point for policy evaluation. Each individual was assigned a three-year tour. Monthly rotation was applied uniformly to the quarterly cohort. An auxiliary run (RUN 2) was made using the nominal three-year tour in which billets were augmented.

RUN 3. First Modification. Contingent upon whether the rating under investigation had a greater requirement at sea or ashore, one of the tours was relaxed by up to two quarters from the nominal three years. The actual modification depended on the magnitude of the manning level imbalance. Uniform detailing was applied to the quarterly cohort up for rotation.

RUN 4. Second Modification. Similar to the first modification of tour lengths, this policy allowed an additional tour length relaxation of up to two quarters. The application represented a differentially applied touring policy which shortened tours to no less than two years for the type duty (sea or shore) with fewer billet requirements, while maintaining the nominal three-year tour for the duty type with the greater requirement. The policy was applied independently to each paygrade composite since imbalances across composites varied. Once again the monthly rotation was one-third of the quarterly cohort. An additional run (RUN 5) was made using these "second modification" tours with billet augmentation to achieve even manning between the sea and shore composites of like paygrades.

RUN 6. Detailer Guidance Application. The final policy to be investigated was an application of monthly proportional detailing to the second modification tours. The detailer guidance was implemented to further reduce manning level differences on the monthly rotation level by recommending the appropriate proportion of the quarterly cohort to be rotated during each month of the quarter.

The policies described above show the feasibility of arriving at and assigning a fixed projected rotation quarter (PRQ) for each individual in the rating. This PRQ would be more precisely defined (through the use of detailing guidance) by notifying the individual nine months prior to rotation of his month of rotation (MOR).

C. MEASURES OF EFFECTIVENESS

With the primary objective of reducing the uncertainty of a tour length, it should be sufficient to note that the assignment of fixed vis-a-vis varying tour lengths represent reductions in uncertainty.

When comparing different rotation policies, the magnitudes of the manning level differences by paygrade between the sea and shore composites should be measured. If X(sea) represents the sea manning level (strength-to-billet ratio) for a certain rating and paygrade at sea, and X(shore) is the counterpart ashore, then a natural measure of the rotational effectiveness for month i is:

$$\theta_i = \sum_{E-1/E-3}^{E-8/E-9} [X(\text{sea}) - X(\text{shore})]^2$$

When computed monthly and summed over the months of the simulation, an overall measure of rotational effectiveness is:

$$\phi = \sum_{\text{months } i} \theta_i$$

A small value of this measure (ϕ) reflects a better policy from an equitable manning viewpoint. The manning level differential term [X(sea) - X(shore)] is squared to attribute more weight to the gross differences in manning level between the paygrade composites.

The manning level balance should not be the sole criterion for measuring policy effectiveness, as extremely high or low manning levels that were equal would be acceptable. Statistics on the average, maximum and minimum manning levels are also compiled during the simulation. Minimum manning levels are always of interest when evaluating rotation policies since they indicate that units may be unable to operate effectively for want of qualified personnel. Likewise, too high manning levels represent the inefficient use of personnel.

Thus, both the magnitude and the difference in manning levels for a paygrade at sea and ashore and the magnitudes of those levels themselves are important when comparing different rotation policies. While the above measures of effectiveness were selected to compare fixed tour policies, they may be useful in drawing certain conclusions with regard to fixed versus variable touring based purely on manning level criteria.

III. THE ENLISTED SEA/SHORE ROTATION MODEL

A simulation model was selected since the interaction of attrition, promotion and rotation is difficult to account for in closed form. Also, it was desirable to introduce some variation to the initial distribution of personnel in the quarterly cohorts and to the number of quarterly accessions to the apprentice rating group. It was not intended that the model exactly portray the present detailing operation. It was, however, to provide a vehicle for the investigation of new rotation schemes and give some measure of their relative effectiveness.

The flow of individuals between the paygrade/duty type composites by rotation or promotion and the effects of attrition and accessions suggest a basic queuing model. FORTRAN was chosen for the simulation language.

A. INPUT ELEMENTS

The five input data variables consisted of promotion and continuation statistics, nominal tour lengths, and current strength and billet profiles. These data were supplied by the Bureau of Naval Personnel and their derivation is fully explained in Appendix B.

Additionally, a set of six control variables, as defined in Appendix C, were used exogeneously to facilitate sensitivity analyses and make the model more flexible to the peculiarities of the rating being investigated.

B. MODEL DESIGN

The simulation model features monthly rotation and quarterly promotion, attrition and accessions. The basic rotation unit is the quarterly cohort as previously described. The matrix of quarterly cohorts is arranged with rows representing the composite (paygrade and sea or shore duty type) and the columns indicative of the number of quarters remaining until the cohort reaches rotation eligibility.

Thus, horizontal movement within the matrix comes with the passage of simulation time. Vertical movement of individuals is accomplished by either rotation, from the cohorts eligible to rotate, or promotion upward to another composite of the same duty type. No attempt was made to model a reduction in paygrade which occurs, though infrequently, through disciplinary action. To maintain some semblance of overall strength stability within the matrix, the quarterly accessions to the E-1/E-3 communities were set equal to the total attrition from the entire rating through the previous quarter. If reliable data on the projected inputs for the six years were available, they could have been used. The division of total accessions between the sea and shore apprentice composites was done quarterly to maintain an equal manning level between them.

The choice of six years for the duration of the simulation was an arbitrary one. It was anticipated that this time frame

would give ample indication of the policy's effect while not implying that the exogeneous variables of attrition or promotion remain static indefinitely.

The enlisted paygrade structure was stratified into 12 composites, six at sea and six ashore. For simplicity, the paygrades of E-8 and E-9 were combined. These personnel represent the upper level leaders and senior supervisors in the enlisted ratings. Similarly, the paygrades of E-1, E-2 and E-3 were combined to serve as a reservoir of apprentices for the rating to draw from. It is into these apprentice blocks that some rating-designated, but more undesignated "strikers," enter and begin serving their tours. Both the input streams and the output statistics are segmented as shown in Figure 1.

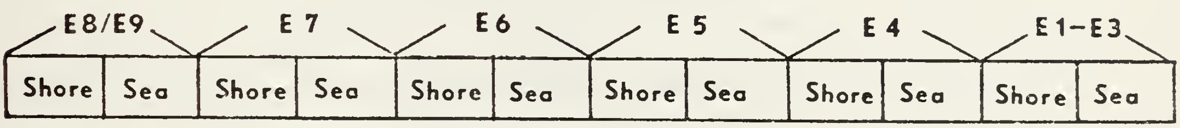


figure 1

Repetitions of each 72-month rotation run were made to investigate the effects of variability in the initial spread of personnel across the tour quarters and in the size of the accessions applied quarterly. Twenty repetitions were made in each case.

The model was separated into a main program and six subroutines. Each is described briefly in the outline portion of the enclosed computer program. Figure 2 is a simple block presentation of the model's design.

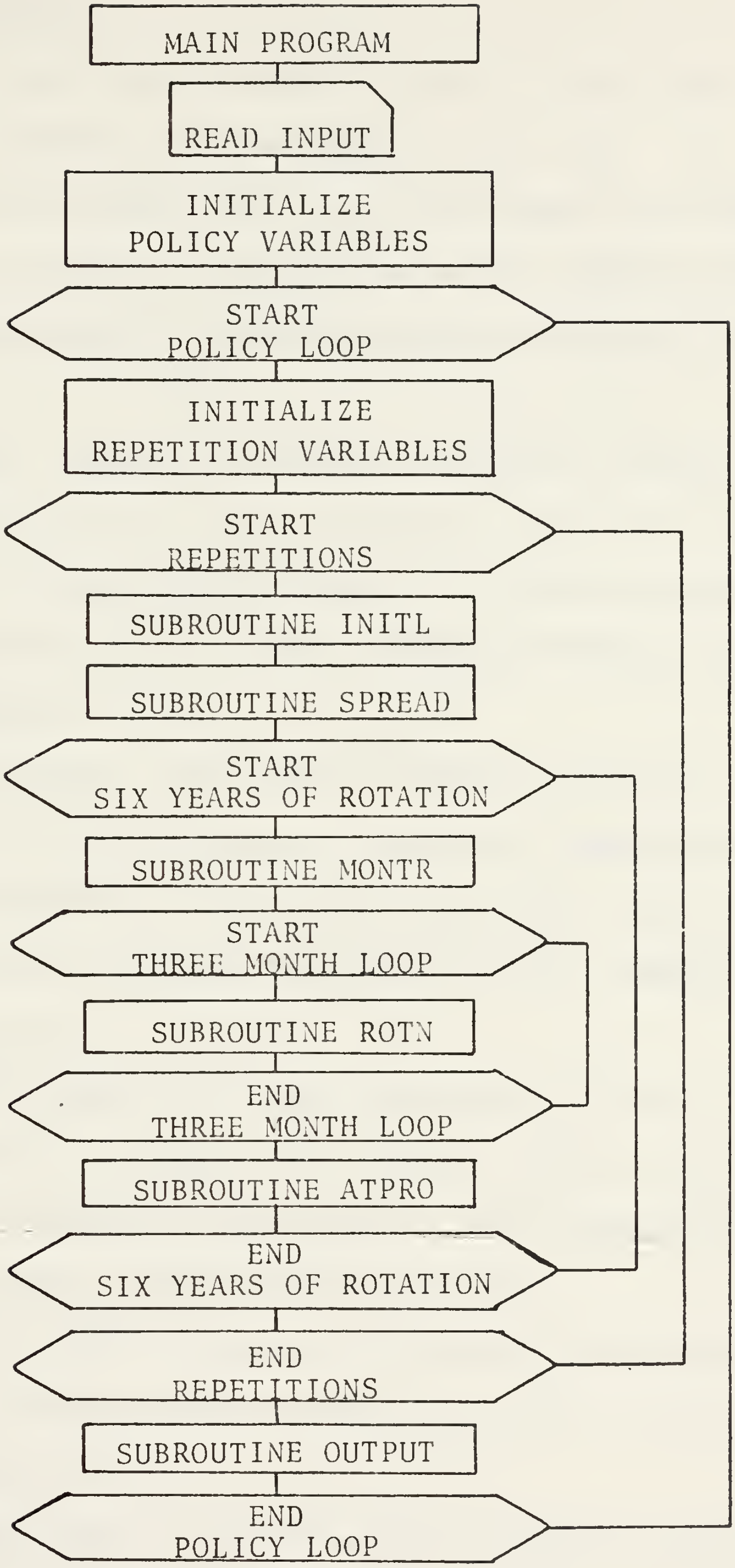

MAIN PROGRAM
READ INPUT
INITIALIZE
POLICY VARIABLES
START
POLICY LOOP
INITIALIZE
REPETITION VARIABLES
START
REPETITIONS
SUBROUTINE INITL
SUBROUTINE SPREAD
START
SIX YEARS OF ROTATION
SUBROUTINE MONTR
START
THREE MONTH LOOP
SUBROUTINE ROTN
END
THREE MONTH LOOP
SUBROUTINE ATPRO
END
SIX YEARS OF ROTATION
END
REPETITIONS
SUBROUTINE OUTPUT
END
POLICY LOOP

Figure 2

C. OUTPUT ELEMENTS

The same output was provided for each of the four basic and two auxiliary billet augmentation runs. The first six types of output data are in the same 12-element format shown in Figure 1. Reference to the sample computer output is recommended for the explanation of output elements given below.

1. "BILLET" Unless the policy in effect involved the augmentation of billets, this element was the same as the initial input of billet requirements. If the run was for billet augmentation, this element reflected the new suggested billet requirement.

2. "BILLET DIFF" This showed changes in billet requirements for the two policies involving augmentation.

3. "CORRECTED PRQ" This element provided the tour lengths in quarters assigned to members of the composite for each policy run.

4. "MAX MAN LEVEL" For each repetition of the 72-month simulation of a policy, the maximum manning level attained by the composite was stored. This element gave the average of these maximum manning levels.

5. "MIN MAN LEVEL" Similar to the above computations, the average of the minimum manning levels was recorded for this output statistics.

6. "AVE MAN LEVEL" A gross average manning level for each composite was recorded under this heading. If 20

repetitions of 72 months rotation for each policy were run, the gross composite average manning level was computed from 1440 (20 times 72) observations.

The next section of output was devoted to recording the values of the monthly objective function, θ_i, under the heading of "SUMSQ ML DIFF." The monthly θ_i were summed over the 72 rotation intervals and presented as the overall measure of effectiveness, ϕ, beside the title, "SUM OF SUMSQ ML DIFF."

A graphic presentation of the monthly objective function was made to facilitate the interpretation of results. For this the CALCOMP plotter was used to show the value of the monthly θ_i for the rating under investigation.

IV. CONCLUSIONS AND RECOMMENDATIONS

The Enlisted Sea/Shore Rotation Model provides a procedure for the reassignment of personnel on a fixed tour basis between the sea and shore composites. Within the framework of this methodology, a series of basic tour length and billet augmentation policies were investigated. The assignment of a fixed PRQ and subsequent month of rotation (MOR) specifically addressed the reduction of individual uncertainty. The use of monthly proportional (detailing guidance) rotation eligibility allowed a micro-level correction of manning level differences.

A. INTERPRETATION OF RESULTS

Tabled below are the values of the objective function ϕ for three representative ratings where the standard control variables, as explained in Appendix A, were utilized.

Policy		Radioman	Machinistmate	Personnelman
1	3/3 Tours	58.6	1676.0	835.9
3	MOD1	34.3	1447.5	543.4
4	MOD2	20.2	1222.0	357.8
6	Proportional Detailing	17.8	1038.5	277.5

More inclusive measures of effectiveness, such as manning level magnitudes, are provided in the sample computer output for the three ratings.

As indicated by the tabled data, the relaxation of tour lengths and the application of detailing guidance provided a sizeable improvement in the objective function for all three ratings. The average manning level across the rating showed less variability as tours were modified and detailing guidance was applied. This was indicative of a more efficient overall assignment of personnel to billets. The absolute differences between the average maximum and minimum manning levels within the composites were also reduced.

It was indicated earlier that fixing the tour lengths for a composite would facilitate the use of promotion as one tool in regulating the strength profile. This procedure was briefly applied to the radioman rating with a resulting 23 percent reduction in the three-year tour objective function (ϕ). The regulated promotion stream necessary to achieve this reduction is tabled in Appendix A. It is understood that there is a high correlation between promotion and continuation in the service; thus the sole application of promotion to achieve manning balance might be counter-productive. Reference 3 proposes a computerized advancement planning model which could be applied more effectively to this type of fixed tour length rotation. Reference 4 discusses a methodology for recruit input planning that could likewise be applied to fixed tour lengths.

Policy runs two and five entail billet augmentation applications to the fixed tours. This procedure might be

useful in the determination of additional billet requirements for shore "compensation" of a rating exhibiting gross differences in sea and shore billet requirements. One such rating is the machinistmate, and the suggested billet augmentation pattern appears in the sample computer output.

B. RECOMMENDATIONS

The Enlisted Sea/Shore Rotation Model is the by-product of an attempt to evaluate the effectiveness of certain rotation schemes based on a premise of fixed tour lengths. It is a basic queuing simulation that could be modified to investigate other facets of rotation management. Some extensions of the present application might include the following.

1. A complete investigation of the use of accessions and feasible promotion rates to achieve manning criteria in a fixed tour length environment.

2. The implementation of a major billet reorganization for the rating. This could come about by the losses or gains of ships/shore installations or the introduction of a new weapons system.

3. A costing feature could present tradeoffs between manning criteria and the cost of the required rotation moves.

4. The improvement in manning criteria to be achieved by allowing billets to be manned by other than specified paygrades or ratings.

5. The model could incorporate obligated service requirements for rotation eligibility to either the shore or sea community.

It is believed that the reduction of the individual career sailor's rotation date uncertainty is a sound investment in his future retention. The elimination of the variable tour length in rotation management represents a loss in flexibility to some extent, but it also will focus the attention of the rotation manager on other alternative measures to achieve the same result within the confines of stable tour patterns.

APPENDIX A: SENSITIVITY ANALYSES

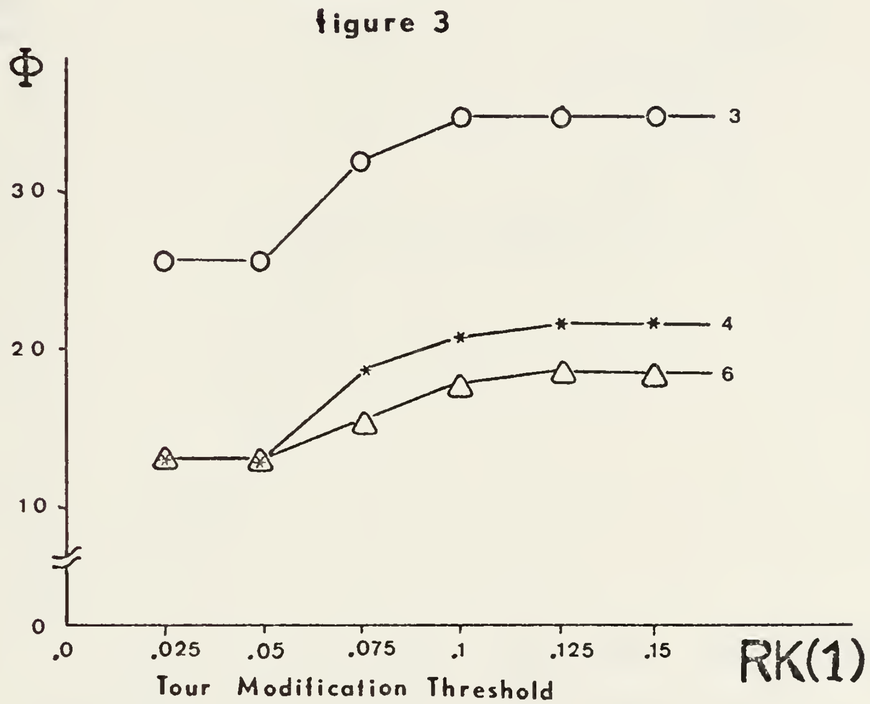
This appendix is concerned with the sensitivity of the overall objective function ϕ to the separate applications of the control variables. Since the model was initially conceived to assign some relative effectiveness measure to the various policies tested, it could be argued that any set of reasonable control variables would adequately show this. An investigation of the effects of the control criteria is, however, instructive to an overall understanding of the model. A full description of the use of the control variables is provided in Appendix C.

The radioman rating (rating code 1500) was chosen for the analysis. Although not considered a shore "deprived" rating, the radioman does have approximately twice as many sea as shore billets. The sensitivity of the separate controls was tested using the standard values listed below, changing only the specific variable under investigation.

Control Variable	RK(1)	RK(2)	RK(3)	RK(4)	RK(5)	RK(6)
Standard Value	.10	.05	.025	2.0	.00	.00

Figure 3 is a plot of the tour modification threshold, RK(1), against ϕ for the indicated policy run. For average manning level differences greater than RK(1), the tour length was modified in the manner specified in Appendix C. From Figure 3 it appears that for this particular rating,

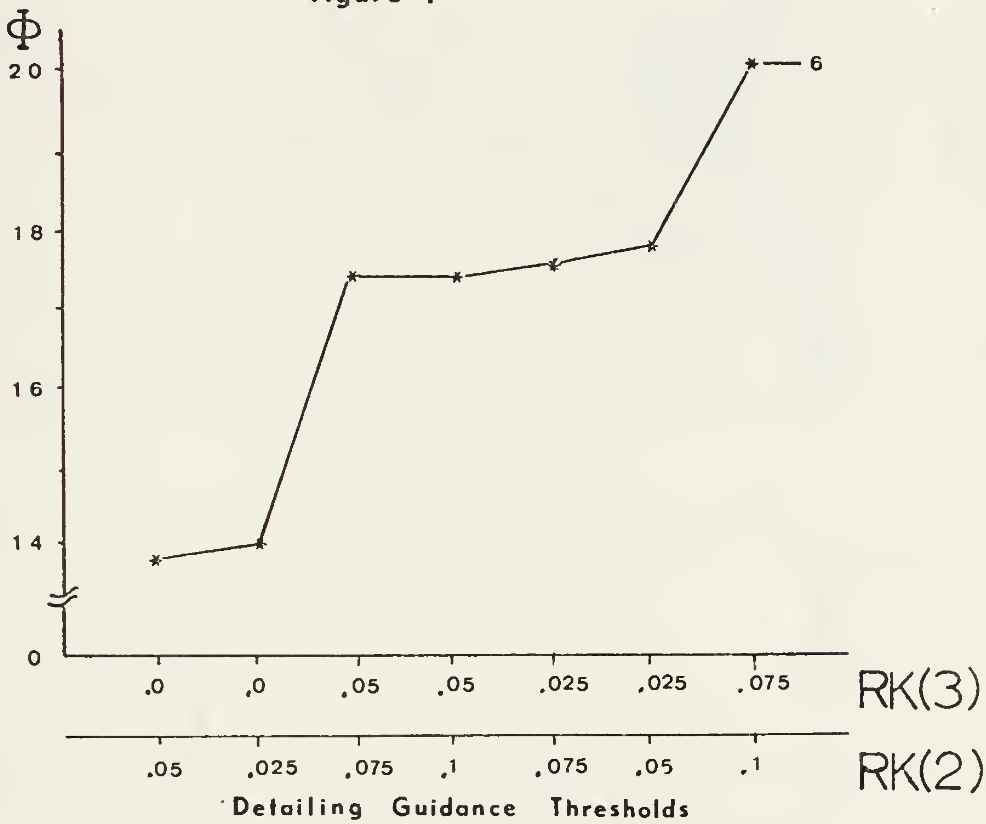
a lower threshold would produce a lower (better) objective function. The better value of .05 will be used in a subsequent evaluation of a better mix of the first three control variables.



In a similar fashion, the two variables involved with the application of detailer guidance (policy six) are plotted against the objective function in Figure 4. These seven two-variable sets represent only a few of the possible combinations of proportional detailing thresholds [RK(2) and RK(3)]. A system of applying extreme proportioning where monthly manning level differentials are greater than .05 and

moderate detailing elsewhere appears to be more "optimal" than the standard variable application. It was found that the sensitivity of the threshold controls depended in part on the rating under investigation.

figure 4



Figures 5a and 5b are a comparison of the monthly squared manning level differentials utilizing the standard and more "optimal" threshold sets respectively. The better detailing guidance threshold set is .00 and .05 for RK(3) and RK(2).

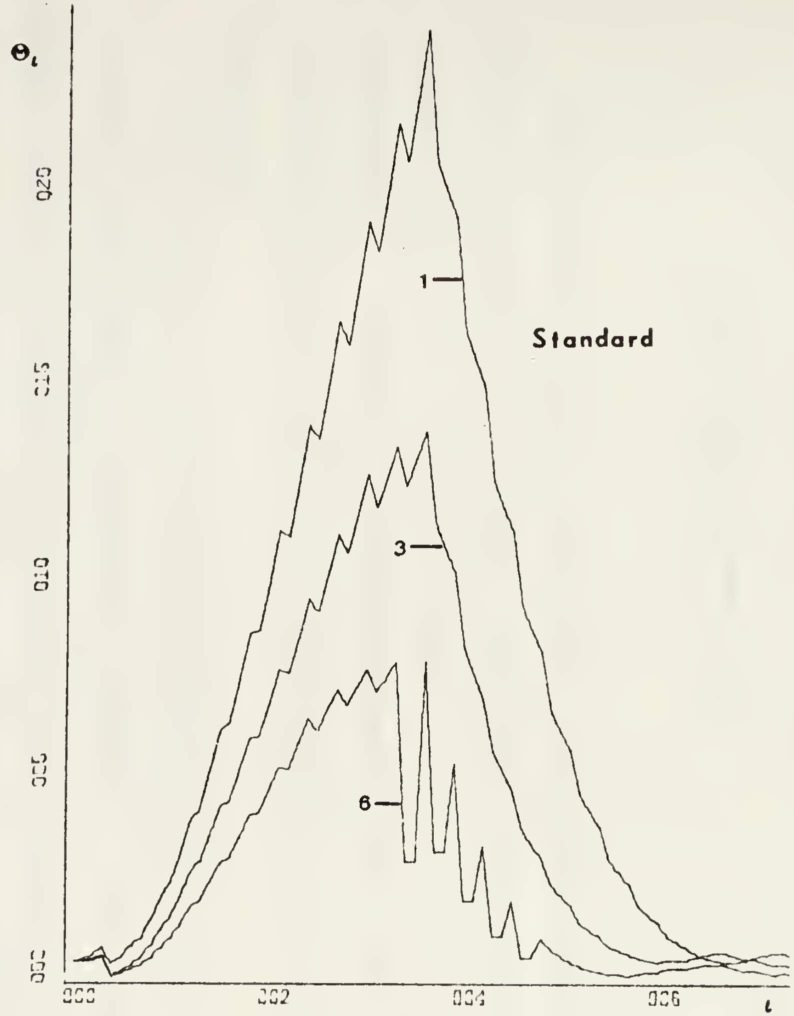


figure 5a

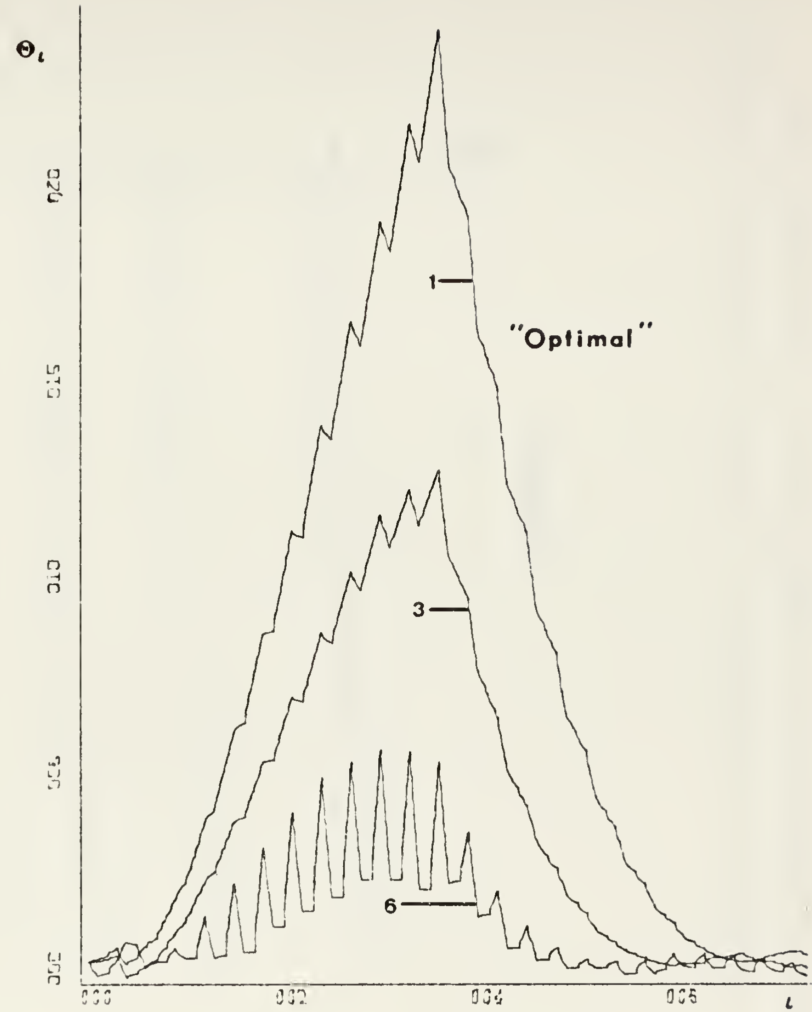
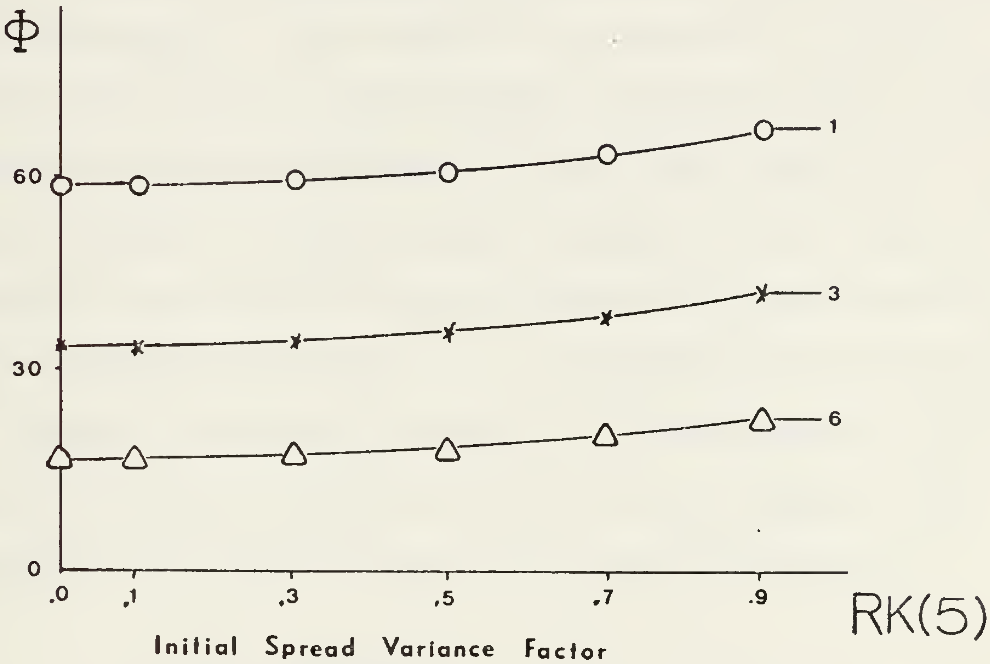


figure 5b

X-SCALE=2.00E+01 UNITS INCH.
Y-SCALE=5.00E-01 UNITS INCH.

The sensitivity of the model to variations in the initial spread of quarterly cohorts is depicted in Figure 6.

figure 6

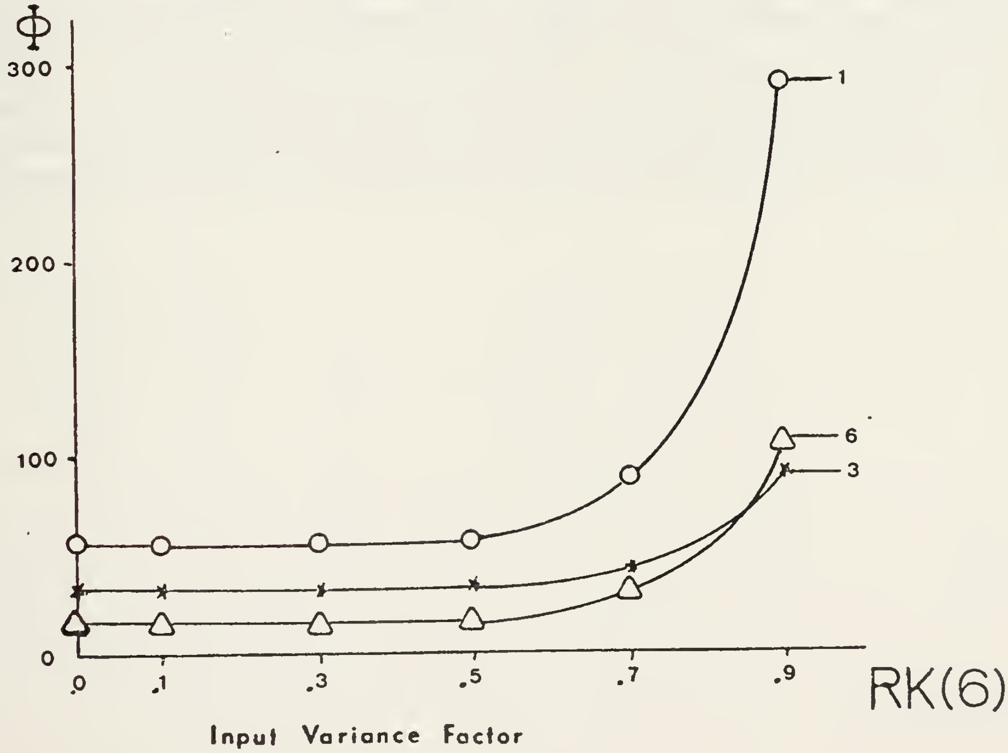


With no variability each cohort reflected only the effects of attrition whereby, relatively fewer personnel occupied the cohort that had longer to serve before rotation eligibility. Likewise, more personnel in the cohort had attained promotion toward the end of their tour than at the beginning.

Variability was achieved by changing the initial cohort size and the number promoted by a factor of up to plus or minus RK(5). As Figure 6 indicates, the objective function is relatively insensitive to this type of variation.

A second method for introducing variation was applied to the quarterly accessions of apprentice (E-1/E-3) composites. The nominal quarterly input (sum of previous quarter's total attrition) was changed by a factor of plus or minus RK(6) or less, to achieve some measure of accession allocation variability. This effect is illustrated in Figure 7 and does not appear to appreciably change the value of the objective function for values of RK(6) less than .70. Greater variability caused major changes in the value of ϕ and also a crossover in the preference of proportional over uniform detailing policies. It is hypothesized that this input-induced instability results in oscillations of the quarterly rotation eligibles which in turn hampers the predictability of the proportional detailing process.

figure 7



The basic 72-month simulation was extended to 96 months to investigate the possibility that a cyclic pattern was developing in the values of the monthly objective function over the longer period. This was not found to be the case with the ratings tested. The level of θ_i remained relatively constant between the six and eight-year points.

The sensitivity of the exogeneous promotion stream to improvement of ϕ was studied briefly to support the hypothesis that promotion could be applied as a tool for strength manipulations. The table below represents one such regulated promotion stream which resulted in a reduction of ϕ from 58.6 to 44.9 using the 3/3 tour length policy. Similar reductions were observed for all policies under the new regulated promotion stream.

	E 7		E 6		E 5		E 4		E1-E3	
Promotion	Shore	Sea	Shore	Sea	Shore	Sea	Shore	Sea	Shore	Sea
Existing	.0975	.0797	.0787	.0757	.1186	.0895	.5160	.4490	.8140	.8300
Regulated	.0980	.0800	.0800	.0700	.1300	.0600	.2800	.2800	.8100	.8100

APPENDIX B: DATA SOURCES

The input data streams used in the rotation model were, as explained in the body of the text, 12 element vectors representing the sea and shore paygrade composites. For the purposes of this study, duty types one and six were defined as shore duty and duty types two, three and four were considered sea duty. The personnel in type duty five (neutral time for rotation purposes) were ignored.

Continuation statistics used to compute a composite's quarterly attrition were provided by PERS N under the title "Yearly Continuation Rates for FY-72." They were tabled by rating, paygrade and duty type and are current as of 30 July 1972. The continuation fraction for a composite can be thought of as the ratio of the number of men who were in the composite on 6/30/71 and are still in the Navy on 6/30/72, to the total number of men in the composite on 6/30/71.

Promotion statistics were likewise a product of PERS N and tabled in a form similar to the continuation. The composite promotion fraction is simply the ratio of the number of men who were in the Navy from 6/30/71 to 6/30/72 but who are not in composite X on 6/30/72 to the total number of men in composite X on 6/30/71.

The current strength and billet structures were generated by the Naval Personnel and Training Research Laboratory and current as of 30 August 1972.

APPENDIX C: CONTROL VARIABLES

The simulation program utilizes six control variables which are read in as data to facilitate sensitivity analysis. This allowed the investigation of the effects of certain key parameters and decision thresholds used in the program. The control variables used, their application and the standard values picked for the sample output are as follows:

RK(1). This is the tour length modification threshold. The control was used in the INITL subroutine to modify the present tour length if the average difference in manning levels over the previous run of 72 months was greater than RK(1). A standard value of .10 was used as the threshold for the output shown.

RK(2) and RK(3). These represent the proportional detailing thresholds. For monthly manning level differences between the shore and sea composites of less than RK(3), uniform detailing across the quarter was applied, i.e., one-third of the composite's rotatable population was moved each month. For monthly differences between RK(2) and RK(3), moderate contraction/extension of the tours was undertaken to the extent that either two-thirds or none of the quarter's output was rotated in the first or last month of the quarter. The remaining one-third rotated in the middle month of the quarter. Extreme contraction/extension was applied for monthly manning level differences of greater than RK(2). This meant that all rotation for the composite

took place in either the first or the last month of the quarter. The standard values of .05 and .025 were chosen for RK(2) and RK(3), respectively.

RK(4). This control variable is the unit value by which the tour lengths were changed when required by RK(1). For ratings with more shore than sea billets, the variable was negative, indicating that the sea tours only were to be modified. It should be remembered that the model in its present form starts with tours of three years for everyone and modifies the policy by decrimenting the tour lengths either at sea, for ratings which have more shore requirements, or more commonly by decrimenting the shore tour length for the "seagoing" ratings. As an example, a decriment variable of 2 would mean that when the tour modification threshold RK(1) was exceeded by the composite, the shore tour length would be decrimented by two quarters. The opportunity for tour modification occurs only once in the initial setup for two of the six policies investigated; Runs 3 and 4.

RK(5). This controls the variance to be introduced into the initial spread of strength across the rotation quarters. Using a Monte Carlo technique [Ref. 5], the number of personnel assigned to each quarterly cohort is varied uniformly by plus or minus RK(5) or less. An alternative scheme could have been used to generate random normal variates to be applied to the cohorts.

RK(6). Similar to the above, this control variable introduces variance into the quarterly inputs to the E-1/ E-3 sea and shore composites. The standard values for both of the variance controls is .00.

72 MONTH ENLISTED SEA/SHORE ROTATION SIMULATION

*****OF RADIOMAN ***** CODE RM-1500*****

INPUT DATA

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
STRENGTH	242.	189.	832.	929.	1410.	1906.	1299.	2523.	1787.	4440.	1010.	2324.
BILLET	258.	257.	756.	917.	1278.	1725.	1438.	2899.	1657.	3966.	1087.	2713.
TOUR MOS	36.	36.	36.	36.	36.	36.	36.	36.	36.	36.	36.	36.
CONTINUATION	0.756	0.832	0.848	0.926	0.902	0.933	0.723	0.619	0.528	0.639	0.814	0.786
PROMOTION	0.0	0.0	0.097	0.080	0.079	0.076	0.119	0.089	0.516	0.449	0.814	0.830

UNIFORM DETAILING POLICY

EXISTING BILLETS 3/3 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	258.	257.	756.	917.	1278.	1725.	1438.	2899.	1657.	3966.	1087.	2713.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
MAX MAN LEVEL	1.341	1.357	1.213	1.097	1.578	1.108	1.939	1.476	1.129	1.109	1.365	1.260
MIN MAN LEVEL	0.933	0.737	0.815	0.796	0.932	0.769	0.948	0.680	0.710	0.627	0.482	0.462
AVE MAN LEVEL	1.291	1.275	1.089	0.901	1.291	0.953	1.574	0.927	0.799	0.748	1.169	1.092
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3
SUMSQ ML DIFF	0.4	0.4	0.5	0.6	0.7	0.8	0.9	0.9	1.0	1.2	1.1	1.3
SUMSQ ML DIFF	1.4	1.4	1.5	1.7	1.6	1.8	1.9	1.9	2.0	2.2	2.1	2.3
SUMSQ ML DIFF	2.4	2.1	2.0	2.0	1.7	1.6	1.5	1.3	1.2	1.2	1.0	0.9
SUMSQ ML DIFF	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.2
SUMSQ ML DIFF	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

SUM OF SUMSQ ML DIFF 58.6

AUGMENTED BILLETS 3/3 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	261.	257.	914.	917.	1731.	1725.	2441.	2899.	1769.	3966.	1164.	2713.
BILLET DIFF	3.	0.	158.	0.	453.	0.	1003.	0.	112.	0.	77.	0.
CORRECTED PRO	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
MAX MAN LEVEL	1.325	1.357	1.003	1.097	1.165	1.108	1.143	1.476	1.058	1.109	1.275	1.260
MIN MAN LEVEL	0.922	0.737	0.674	0.796	0.688	0.769	0.559	0.680	0.665	0.627	0.450	0.462
AVE MAN LEVEL	1.275	1.275	0.901	0.901	0.953	0.953	0.927	0.927	0.748	0.748	1.092	1.092
SUMSQ ML DIFF	0.3	0.2	0.2	0.2	0.4	0.4	0.3	0.2	0.2	0.2	0.1	0.1
SUMSQ ML DIFF	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
SUMSQ ML DIFF	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4
SUMSQ ML DIFF	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0
SUMSQ ML DIFF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4

SUM OF SUMSQ ML DIFF 10.6

EXISTING BILLETS MOD1 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	258.	257.	756.	917.	1278.	1725.	1438.	2899.	1657.	3966.	1087.	2713.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	12.	12.	10.	12.	10.	12.	10.	12.	12.	12.	12.	12.
MAX MAN LEVEL	1.273	1.394	1.146	1.118	1.379	1.145	1.849	1.484	1.129	1.109	1.365	1.260
MIN MAN LEVEL	0.933	0.737	0.822	0.923	0.915	0.920	0.943	0.743	0.710	0.627	0.483	0.463
AVE MAN LEVEL	1.232	1.298	0.992	0.993	1.165	1.050	1.493	0.966	0.799	0.748	1.169	1.091
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2
SUMSQ ML DIFF	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8	0.8	0.9
SUMSQ ML DIFF	1.0	1.0	1.0	1.1	1.1	1.2	1.3	1.2	1.3	1.4	1.3	1.3
SUMSQ ML DIFF	1.4	1.2	1.1	1.1	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4
SUMSQ ML DIFF	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

SUM OF SUMSQ ML DIFF 34.3

EXISTING BILLETS MOD2 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	258.	257.	756.	917.	1278.	1725.	1438.	2899.	1657.	3966.	1087.	2713.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	12.	12.	10.	12.	8.	12.	8.	12.	12.	12.	12.	12.
MAX MAN LEVEL	1.291	1.394	1.123	1.119	1.149	1.198	1.726	1.497	1.129	1.109	1.367	1.262
MIN MAN LEVEL	0.933	0.737	0.841	0.902	0.894	1.091	0.935	0.831	0.710	0.627	0.483	0.463
AVE MAN LEVEL	1.231	1.288	0.967	1.002	1.030	1.151	1.394	1.014	0.800	0.749	1.171	1.094
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2
SUMSQ ML DIFF	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.6	0.6	0.6
SUMSQ ML DIFF	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
SUMSQ ML DIFF	0.7	0.6	0.5	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.1
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

SUM OF SUMSQ ML DIFF 20.2

AUGMENTED BILLETS MOD2 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	247.	257.	729.	917.	1144.	1725.	1977.	2899.	1769.	3966.	1164.	2713.
BILLET DIFF	-11.	0.	-27.	0.	-134.	0.	539.	0.	112.	0.	77.	0.
CORRECTED PRO	12.	12.	10.	12.	8.	12.	8.	12.	12.	12.	12.	12.
MAX MAN LEVEL	1.350	1.394	1.164	1.119	1.283	1.198	1.255	1.497	1.058	1.109	1.277	1.262
MIN MAN LEVEL	0.976	0.737	0.872	0.902	0.999	1.091	0.680	0.831	0.665	0.627	0.451	0.463
AVE MAN LEVEL	1.288	1.288	1.002	1.002	1.151	1.151	1.014	1.014	0.749	0.749	1.094	1.094
SUMSQ ML DIFF	0.2	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.0	0.0	0.0
SUMSQ ML DIFF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
SUMSQ ML DIFF	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMSQ ML DIFF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

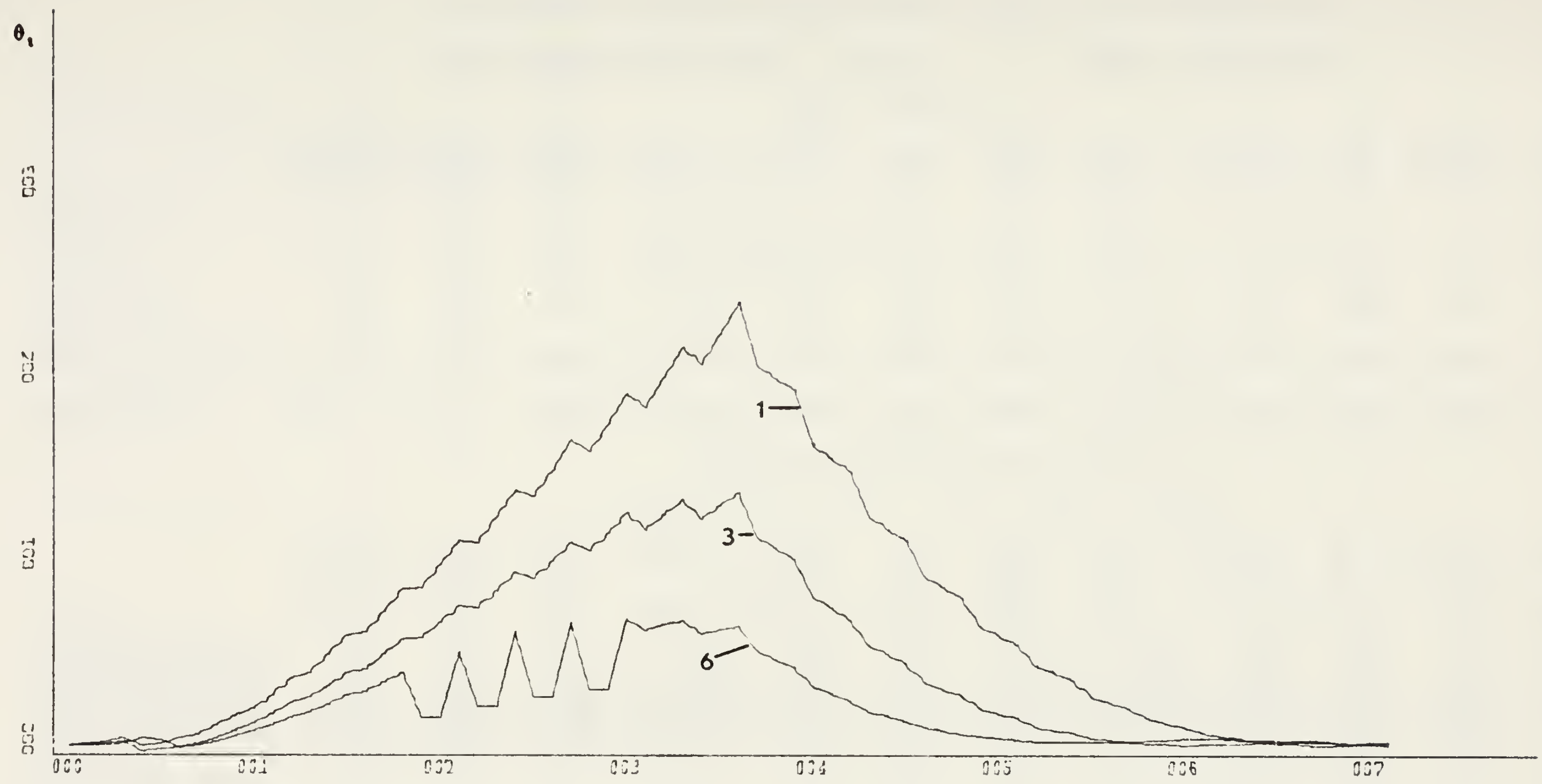
SUM OF SUMSQ ML DIFF 5.8

DETAILING GUIDANCE POLICY

EXISTING BILLETS MOD2 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	258.	257.	756.	917.	1278.	1725.	1438.	2899.	1657.	3966.	1087.	2713.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	12.	12.	10.	12.	8.	12.	8.	12.	12.	12.	12.	12.
MAX MAN LEVEL	1.338	1.394	1.123	1.207	1.241	1.198	1.726	1.565	1.129	1.109	1.367	1.262
MIN MAN LEVEL	0.933	0.737	0.841	0.902	0.894	1.044	0.935	0.831	0.691	0.627	0.483	0.463
AVE MAN LEVEL	1.240	1.278	0.975	0.995	1.047	1.138	1.370	1.025	0.795	0.752	1.171	1.094
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.2
SUMSQ ML DIFF	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.2	0.2	0.6	0.3	0.3
SUMSQ ML DIFF	0.7	0.3	0.3	0.7	0.4	0.4	0.7	0.7	0.7	0.7	0.7	0.7
SUMSQ ML DIFF	0.7	0.6	0.5	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.1
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SUMSQ ML DIFF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

SUM OF SUMSQ ML DIFF 17.8



X-SCALE=1.00E+01 UNITS INCH.
Y-SCALE=1.00E+00 UNITS INCH.
SUM ØF SQUARES ØF MANNING LEVEL DIFF BY MØS*
BY INDICATED PØLICY FØR RADIØMEN BY W.H.WRIGHT

72 MONTH ENLISTED SEA/SHORE ROTATION SIMULATION

OF MACHINISTMATES *** CODE MM-3700**

INPUT DATA

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
STRENGTH	317.	458.	658.	964.	1288.	2394.	713.	4026.	143.	3113.	23.	2969.
BILLET	296.	652.	892.	1086.	1431.	3042.	1335.	4397.	89.	5719.	27.	1086.
TOUR MOS	36.	36.	36.	36.	36.	36.	36.	36.	36.	36.	36.	36.
CONTINUATION	0.812	0.864	0.855	0.915	0.834	0.869	0.775	0.708	0.794	0.651	0.521	0.880
PROMOTION	0.0	0.0	0.206	0.226	0.136	0.140	0.251	0.449	0.518	0.545	0.670	0.788

UNIFORM DETAILING POLICY

EXISTING BILLETS 3/3 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	296.	652.	892.	1086.	1431.	3042.	1335.	4397.	89.	5719.	27.	1086.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
MAX MAN LEVEL	3.661	2.085	1.581	1.270	2.410	1.271	1.152	0.902	6.683	0.550	3.708	3.391
MIN MAN LEVEL	1.084	0.685	0.426	0.499	0.441	0.338	0.315	0.251	2.348	0.363	0.757	1.292
AVE MAN LEVEL	2.760	1.250	1.076	0.842	1.484	0.770	0.733	0.435	4.540	0.467	2.591	2.934
SUMSQ ML DIFF	5.0	6.9	9.7	14.1	8.4	13.5	19.7	19.0	24.9	31.7	27.3	33.1
SUMSQ ML DIFF	39.3	32.1	37.2	42.7	34.0	38.5	43.2	34.3	38.5	42.8	34.0	37.8
SUMSQ ML DIFF	41.8	33.4	36.9	40.5	33.0	36.5	40.0	33.3	36.8	40.4	34.3	37.8
SUMSQ ML DIFF	41.5	33.4	34.2	35.3	27.7	27.7	27.7	22.1	22.3	22.6	18.0	18.2
SUMSQ ML DIFF	18.4	14.7	14.9	15.2	12.1	12.3	12.7	10.0	10.3	10.7	8.4	8.7
SUMSQ ML DIFF	9.2	7.2	7.6	8.1	6.4	6.8	7.4	5.9	6.5	7.1	5.9	6.5

SUM OF SUMSQ ML DIFF 1676.0

AUGMENTED BILLETS 3/3 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	654.	652.	1139.	1086.	2760.	3042.	2248.	4397.	865.	5719.	24.	1086.
BILLET DIFF	358.	0.	247.	0.	1329.	0.	913.	0.	776.	0.	-3.	0.
CORRECTED PRO	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
MAX MAN LEVEL	1.658	2.085	1.238	1.270	1.250	1.271	0.684	0.902	0.688	0.550	4.199	3.391
MIN MAN LEVEL	0.491	0.685	0.334	0.499	0.229	0.338	0.187	0.251	0.242	0.363	0.857	1.292
AVE MAN LEVEL	1.250	1.250	0.842	0.842	0.770	0.770	0.435	0.435	0.467	0.467	2.934	2.934
SUMSQ ML DIFF	3.9	3.6	3.0	2.9	1.1	1.0	0.9	0.9	0.9	0.8	0.8	0.8
SUMSQ ML DIFF	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	1.0	1.0	1.1
SUMSQ ML DIFF	1.2	1.0	1.0	1.0	0.9	1.0	1.1	1.1	1.2	1.5	1.5	1.8
SUMSQ ML DIFF	2.2	1.9	2.0	2.2	1.5	1.6	1.7	1.1	1.1	1.3	0.7	0.8
SUMSQ ML DIFF	1.0	0.5	0.6	0.8	0.3	0.5	0.7	0.3	0.5	0.8	0.5	0.7
SUMSQ ML DIFF	1.0	0.8	1.1	1.5	1.3	1.6	2.0	2.0	2.3	2.8	2.8	3.2

SUM OF SUMSQ ML DIFF 92.9

EXISTING BILLETS MOD1 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	296.	652.	892.	1086.	1431.	3042.	1335.	4397.	89.	5719.	27.	1086.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	10.	12.	10.	12.	10.	12.	10.	12.	10.	12.	12.	12.
MAX MAN LEVEL	3.142	2.089	1.376	1.298	2.140	1.281	1.070	0.903	6.697	0.547	3.687	3.364
MIN MAN LEVEL	1.078	0.693	0.454	0.675	0.451	0.475	0.281	0.285	2.339	0.364	0.757	1.294
AVE MAN LEVEL	2.434	1.396	0.950	0.957	1.328	0.854	0.665	0.451	4.367	0.468	2.582	2.921
SUMSQ ML DIFF	5.0	6.9	9.6	13.9	8.6	13.8	20.1	19.2	25.2	32.0	27.4	33.1
SUMSQ ML DIFF	39.3	31.8	36.9	42.2	33.3	37.7	42.2	33.1	37.1	41.2	32.3	36.0
SUMSQ ML DIFF	39.7	31.2	34.5	37.9	30.3	33.5	36.8	28.9	30.8	32.7	26.2	27.7
SUMSQ ML DIFF	29.4	23.0	23.5	24.3	18.5	18.6	18.7	14.5	14.8	15.2	11.8	12.0
SUMSQ ML DIFF	12.4	9.6	9.9	10.3	8.0	8.3	8.8	6.8	7.2	7.7	6.0	6.5
SUMSQ ML DIFF	7.1	5.6	6.1	6.7	5.5	6.1	6.7	5.6	6.0	6.4	5.3	5.8

SUM OF SUMSQ ML DIFF 1447.5

EXISTING BILLETS MOD2 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	296.	652.	892.	1086.	1431.	3042.	1335.	4397.	89.	5719.	27.	1086.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	8.	12.	10.	12.	8.	12.	8.	12.	8.	12.	12.	12.
MAX MAN LEVEL	2.714	2.071	1.246	1.240	1.810	1.296	0.937	0.904	6.669	0.546	3.675	3.354
MIN MAN LEVEL	1.064	0.704	0.552	0.778	0.465	0.647	0.251	0.333	2.326	0.365	0.757	1.294
AVE MAN LEVEL	2.227	1.499	0.894	1.001	1.163	0.945	0.582	0.470	4.102	0.471	2.576	2.913
SUMSQ ML DIFF	5.0	6.8	9.4	13.6	9.2	14.4	20.8	19.7	25.6	32.3	27.4	33.0
SUMSQ ML DIFF	39.1	31.4	36.3	41.4	32.4	36.6	40.8	31.8	35.5	39.4	30.6	33.9
SUMSQ ML DIFF	37.3	27.5	28.8	30.1	22.5	23.5	24.4	18.9	20.0	21.2	16.9	18.1
SUMSQ ML DIFF	19.4	15.1	15.7	16.4	12.3	12.4	12.7	9.6	10.0	10.4	7.9	8.2
SUMSQ ML DIFF	8.6	6.6	6.9	7.3	5.7	6.0	6.5	5.1	5.5	6.0	4.9	5.3
SUMSQ ML DIFF	5.8	4.8	5.2	5.6	4.7	5.1	5.7	4.7	5.1	5.6	4.6	5.0

SUM OF SUMSQ ML DIFF 1222.0

AUGMENTED BILLETS MOD2 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	440.	652.	796.	1086.	1760.	3042.	1654.	4397.	775.	5719.	24.	1086.
BILLET DIFF	144.	0.	-96.	0.	329.	0.	319.	0.	686.	0.	-3.	0.
CORRECTED PRO	8.	12.	10.	12.	8.	12.	8.	12.	8.	12.	12.	12.
MAX MAN LEVEL	1.826	2.071	1.395	1.240	1.472	1.296	0.756	0.904	0.766	0.546	4.155	3.354
MIN MAN LEVEL	0.716	0.704	0.619	0.778	0.378	0.647	0.203	0.333	0.267	0.365	0.856	1.294
AVE MAN LEVEL	1.499	1.499	1.001	1.001	0.945	0.945	0.470	0.470	0.471	0.471	2.913	2.913
SUMSQ ML DIFF	3.5	3.2	2.7	2.6	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.6
SUMSQ ML DIFF	0.6	0.6	0.7	0.8	0.8	0.9	1.0	1.0	1.2	1.3	1.3	1.5
SUMSQ ML DIFF	1.6	1.4	1.4	1.4	1.2	1.2	1.2	1.1	1.2	1.3	1.2	1.3
SUMSQ ML DIFF	1.6	1.2	1.2	1.5	0.8	0.9	1.0	0.5	0.6	0.9	0.4	0.5
SUMSQ ML DIFF	0.8	0.3	0.5	0.8	0.5	0.7	1.0	0.8	1.0	1.4	1.3	1.6
SUMSQ ML DIFF	2.0	1.7	1.8	2.0	1.6	1.7	1.9	1.5	1.5	1.6	1.2	1.2

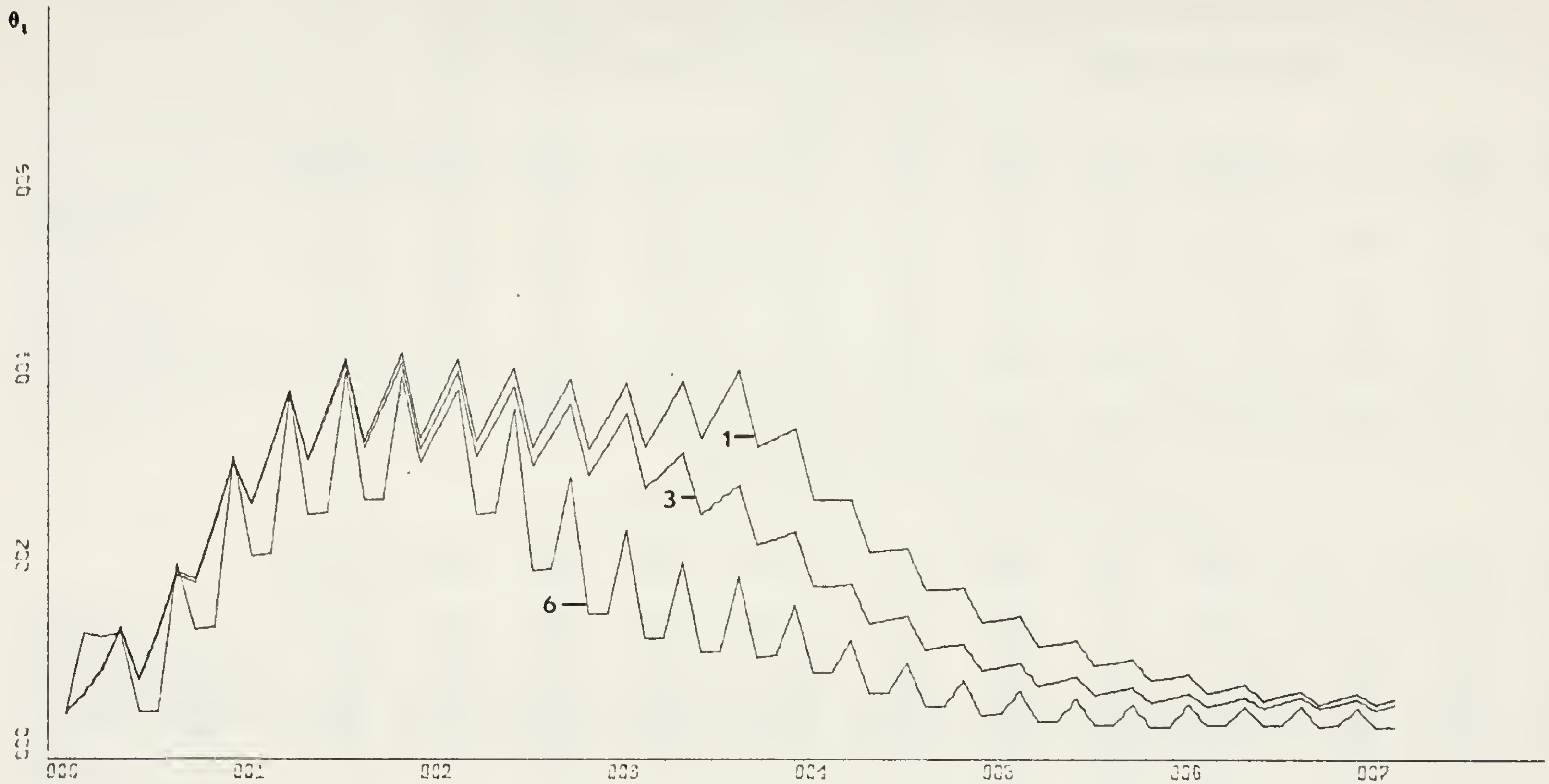
SUM OF SUMSQ ML DIFF 84.7

DETAILING GUIDANCE POLICY

EXISTING BILLETS MOD2 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	296.	652.	892.	1086.	1431.	3042.	1335.	4397.	89.	5719.	27.	1086.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	8.	12.	10.	12.	8.	12.	8.	12.	8.	12.	12.	12.
MAX MAN LEVEL	2.697	2.206	1.246	1.234	1.810	1.359	0.937	0.881	6.669	0.549	3.675	3.362
MIN MAN LEVEL	0.959	0.706	0.564	0.778	0.467	0.647	0.255	0.333	2.259	0.365	0.773	1.294
AVE MAN LEVEL	2.054	1.577	0.899	0.996	1.128	0.963	0.568	0.473	3.829	0.476	2.535	2.911
SUMSQ ML DIFF	5.0	13.4	13.1	13.6	5.0	5.1	20.8	14.0	14.1	32.3	21.7	21.9
SUMSQ ML DIFF	39.1	26.2	26.3	41.4	27.6	27.7	40.8	31.8	35.5	39.4	26.2	26.3
SUMSQ ML DIFF	37.3	20.1	20.2	30.1	15.5	15.5	24.4	12.8	12.9	21.2	11.5	11.5
SUMSQ ML DIFF	19.4	10.9	11.0	16.4	9.3	9.3	12.7	7.0	7.0	10.4	5.8	5.8
SUMSQ ML DIFF	8.6	4.8	4.8	7.3	4.1	4.1	6.5	3.6	3.7	6.0	3.6	3.6
SUMSQ ML DIFF	5.8	3.6	3.6	5.6	3.7	3.7	5.7	3.6	3.6	5.6	3.4	3.4

SUM OF SUMSQ ML DIFF 1038.5



X-SCALE=1.00E+01 UNITS INCH.
Y-SCALE=2.00E+01 UNITS INCH.
SUM ØF SQUARES ØF MANNING LEVEL DIFF BY MØS*
EXISTING BILLETS MACHINISTMATE BY W H WRIGHT

72 MONTH ENLISTED SEA/SHORE ROTATION SIMULATION

OF PERSONNELMAN *** CODE PN-1800**

INPUT DATA

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
STRENGTH	220.	69.	444.	272.	723.	541.	774.	571.	635.	886.	332.	456.
BILLET	239.	105.	523.	128.	935.	692.	842.	611.	759.	644.	740.	351.
TOUR MOS	36.	36.	36.	36.	36.	36.	36.	36.	36.	36.	36.	36.
CONTINUATION	0.813	0.849	0.964	0.912	0.951	0.722	0.801	0.590	0.764	0.798	0.872	0.0
PROMOTION	0.0	0.0	0.207	0.228	0.185	0.200	0.329	0.316	0.578	0.703	0.887	0.933

UNIFORM DETAILING POLICY

EXISTING BILLETS 3/3 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	239.	105.	523.	128.	935.	692.	842.	611.	759.	644.	740.	351.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
MAX MAN LEVEL	2.175	4.499	0.926	4.022	0.880	1.004	0.928	1.518	1.087	1.360	1.074	1.313
MIN MAN LEVEL	0.883	0.686	0.685	2.189	0.637	0.601	0.729	0.576	0.507	0.434	0.414	0.693
AVE MAN LEVEL	1.433	3.379	0.800	3.322	0.710	0.826	0.810	0.808	0.892	0.530	0.946	0.875
SUMSQ ML DIFF	2.7	2.9	2.9	3.3	3.9	4.2	4.5	4.7	5.1	5.5	5.9	6.3
SUMSQ ML DIFF	6.8	7.3	7.8	8.3	8.9	9.4	10.0	10.7	11.3	11.9	12.6	13.3
SUMSQ ML DIFF	13.9	14.7	15.4	16.0	16.8	17.6	18.3	19.1	19.9	20.6	21.5	22.3
SUMSQ ML DIFF	23.1	22.3	21.5	20.8	19.9	19.1	18.4	17.6	16.9	16.3	15.6	15.0
SUMSQ ML DIFF	14.4	13.8	13.3	12.8	12.2	11.7	11.3	10.8	10.4	10.0	9.5	9.2
SUMSQ ML DIFF	8.8	8.4	8.1	7.7	7.4	7.1	6.8	6.5	6.2	5.9	5.6	5.4

SUM OF SUMSQ ML DIFF 835.9

AUGMENTED BILLETS 3/3 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	101.	105.	126.	128.	804.	692.	844.	611.	1278.	644.	800.	351.
BILLET DIFF	-138.	0.	-397.	0.	-131.	0.	2.	0.	519.	0.	60.	0.
CORRECTED PRO	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
MAX MAN LEVEL	5.127	4.499	3.840	4.022	1.023	1.004	0.926	1.518	0.646	1.360	0.994	1.313
MIN MAN LEVEL	2.080	0.686	2.843	2.189	0.740	0.601	0.727	0.576	0.301	0.434	0.383	0.693
AVE MAN LEVEL	3.379	3.379	3.322	3.322	0.826	0.826	0.808	0.808	0.530	0.530	0.875	0.875
SUMSQ ML DIFF	5.8	5.4	4.8	4.5	4.5	4.0	3.5	2.7	2.3	1.9	1.4	1.2
SUMSQ ML DIFF	0.9	0.6	0.4	0.3	0.2	0.1	0.1	0.1	0.2	0.3	0.4	0.6
SUMSQ ML DIFF	0.8	1.0	1.2	1.5	1.8	2.2	2.6	2.9	3.3	3.8	4.2	4.8
SUMSQ ML DIFF	5.3	4.7	4.2	3.7	3.1	2.6	2.2	1.8	1.4	1.1	0.9	0.7
SUMSQ ML DIFF	0.5	0.4	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.5	0.6
SUMSQ ML DIFF	0.8	1.0	1.2	1.4	1.6	1.9	2.2	2.5	2.9	3.3	3.6	4.0

SUM OF SUMSQ ML DIFF 137.7

EXISTING BILLETS MOD1 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	239.	105.	523.	128.	935.	692.	842.	611.	759.	644.	740.	351.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	12.	10.	12.	10.	12.	10.	12.	12.	12.	12.	12.	12.
MAX MAN LEVEL	2.204	3.828	0.941	3.519	0.890	0.981	0.928	1.518	1.075	1.360	1.062	1.313
MIN MAN LEVEL	0.887	0.682	0.824	2.177	0.696	0.591	0.729	0.572	0.507	0.431	0.414	0.693
AVE MAN LEVEL	1.571	2.968	0.887	3.039	0.754	0.794	0.807	0.806	0.886	0.527	0.938	0.868
SUMSQ ML DIFF	2.7	2.9	2.8	3.1	3.4	3.6	3.8	3.9	4.2	4.4	4.7	5.0
SUMSQ ML DIFF	5.3	5.6	6.0	6.3	6.7	7.1	7.5	8.0	8.4	8.8	9.3	9.7
SUMSQ ML DIFF	10.2	10.7	11.2	11.6	12.2	12.7	13.2	13.5	13.7	13.9	13.9	13.8
SUMSQ ML DIFF	13.7	13.0	12.2	11.5	11.1	10.6	10.2	9.8	9.4	9.0	8.6	8.3
SUMSQ ML DIFF	7.9	7.6	7.3	7.0	6.8	6.5	6.2	6.0	5.8	5.6	5.4	5.2
SUMSQ ML DIFF	5.0	4.8	4.6	4.5	4.3	4.1	4.0	4.3	4.5	4.8	5.1	5.4

SUM OF SUMSQ ML DIFF 543.4

EXISTING BILLETS MOD2 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	239.	105.	523.	128.	935.	692.	842.	611.	759.	644.	740.	351.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	12.	8.	12.	8.	12.	10.	12.	12.	12.	12.	12.	12.
MAX MAN LEVEL	2.258	3.214	1.003	3.167	0.890	0.981	0.928	1.516	1.073	1.360	1.060	1.313
MIN MAN LEVEL	0.895	0.677	0.849	2.159	0.695	0.591	0.729	0.571	0.507	0.431	0.415	0.694
AVE MAN LEVEL	1.710	2.579	0.955	2.840	0.754	0.793	0.807	0.806	0.885	0.527	0.937	0.867
SUMSQ ML DIFF	2.7	2.8	2.7	3.0	3.5	3.6	3.7	3.7	3.8	3.9	4.1	4.2
SUMSQ ML DIFF	4.4	4.6	4.8	5.0	5.3	5.5	5.7	6.0	6.2	6.5	6.8	7.1
SUMSQ ML DIFF	7.3	7.6	7.7	7.8	7.9	7.8	7.7	7.7	7.6	7.5	7.6	7.5
SUMSQ ML DIFF	7.4	7.1	6.6	6.2	6.0	5.7	5.5	5.3	5.1	4.9	4.7	4.5
SUMSQ ML DIFF	4.3	4.2	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.2	3.0
SUMSQ ML DIFF	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.8	4.0	4.2	4.4	4.5

SUM OF SUMSQ ML DIFF 357.8

AUGMENTED BILLETS MOD2 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	158.	105.	176.	128.	889.	692.	843.	611.	1275.	644.	800.	351.
BILLET DIFF	-81.	0.	-347.	0.	-46.	0.	1.	0.	516.	0.	60.	0.
CORRECTED PRO	12.	8.	12.	8.	12.	10.	12.	12.	12.	12.	12.	12.
MAX MAN LEVEL	3.405	3.214	2.982	3.167	0.937	0.981	0.927	1.518	0.639	1.360	0.981	1.313
MIN MAN LEVEL	1.350	0.677	2.525	2.159	0.731	0.591	0.728	0.571	0.302	0.431	0.384	0.694
AVE MAN LEVEL	2.579	2.579	2.840	2.840	0.793	0.793	0.806	0.806	0.527	0.527	0.867	0.867
SUMSQ ML DIFF	2.2	2.2	1.9	2.0	1.3	1.2	1.1	0.7	0.6	0.6	0.3	0.3
SUMSQ ML DIFF	0.3	0.2	0.2	0.3	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8
SUMSQ ML DIFF	0.9	1.0	1.0	1.1	1.1	1.0	0.9	0.9	0.8	0.7	0.7	0.7
SUMSQ ML DIFF	0.6	0.5	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SUMSQ ML DIFF	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9
SUMSQ ML DIFF	1.0	0.8	0.7	0.6	0.6	0.5	0.4	0.3	0.3	0.2	0.2	0.2

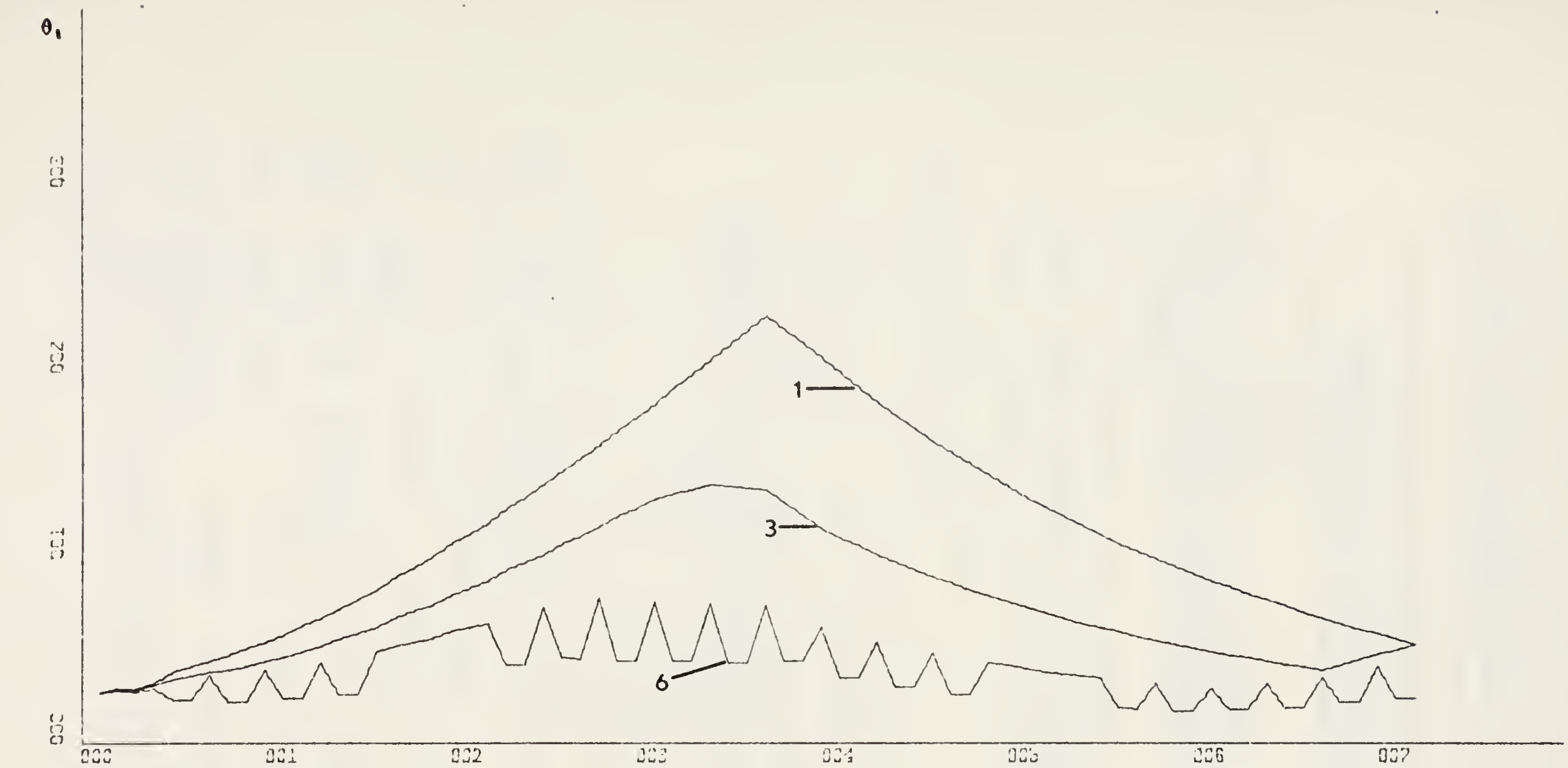
SUM OF SUMSQ ML DIFF 43.6

DETAILING GUIDANCE POLICY

EXISTING BILLETS MOD2 TOUR POLICY

	SHORE E8-E9	SEA E8-E9	SHORE E7	SEA E7	SHORE E6	SEA E6	SHORE E5	SEA E5	SHORE E4	SEA E4	SHORE E1-E3	SEA E1-E3
BILLET	239.	105.	523.	128.	935.	692.	842.	611.	759.	644.	740.	351.
BILLET DIFF	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CORRECTED PRO	12.	8.	12.	8.	12.	10.	12.	12.	12.	12.	12.	12.
MAX MAN LEVEL	2.396	3.214	1.082	3.167	0.944	0.981	0.960	1.500	1.066	1.360	1.059	1.313
MIN MAN LEVEL	0.895	0.677	0.849	2.159	0.672	0.612	0.729	0.584	0.507	0.432	0.418	0.686
AVE MAN LEVEL	1.781	2.417	0.997	2.670	0.769	0.774	0.811	0.800	0.882	0.530	0.936	0.868
SUMSQ ML DIFF	2.7	2.8	2.7	3.0	2.3	2.3	3.7	2.3	2.3	3.9	2.4	2.4
SUMSQ ML DIFF	4.4	2.7	2.7	5.0	5.3	5.5	5.7	6.0	6.2	6.5	4.2	4.2
SUMSQ ML DIFF	7.3	4.6	4.6	7.8	4.5	4.5	7.7	4.4	4.4	7.5	4.3	4.3
SUMSQ ML DIFF	7.4	4.4	4.4	6.2	3.6	3.6	5.5	3.1	3.1	4.9	2.7	2.7
SUMSQ ML DIFF	4.3	4.2	4.1	3.9	3.8	3.7	3.5	1.9	1.9	3.2	1.8	1.8
SUMSQ ML DIFF	3.0	1.8	1.8	3.3	1.9	1.9	3.6	2.2	2.2	4.2	2.5	2.5

SUM OF SUMSQ ML DIFF 277.5



X-SCALE=1.00E+01 UNITS INCH.
Y-SCALE=1.00E+01 UNITS INCH.
SUM ØF SQUARES ØF MANNING LEVEL DIFF BY MØS*
EXISTING BILLETS FØR PERSONNELMAN BY WH WRIGHT

COMPUTER PROGRAM

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**  ENLISTED SEA/SHORE ROTATION MODEL **
** MASTERS THESIS-OPERATIONS RESEARCH **
** BY WILLIAM H. WRIGHT IV, LCDR, USN **
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DEFINITION OF VARIABLES

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EXOGENEOUS VARIABLES

S    COMPOSITE STRENGTH BY PAYGRADE (SEA AND SHORE)

B    COMPOSITE BILLET REQUIREMENTS BY PAYGRADE (SEA
     AND SHORE)

T    PRESENT COMPOSITE TOUR LENGTH IN MONTHS

C    ANNUAL CONTINUATION RATE FOR COMPOSITE

P    ANNUAL PROMOTION RATE FOR COMPOSITE

RK   SIX CONTROL VARIABLES

ENDOGENEOUS VARIABLES

A    VECTOR OF ROTATION MONTH COUNTS

CQ   CORRECTIONAL TOUR IN QUARTERS

D    ATTRITION TO COMPOSITE EACH QUARTER

E    MATRIX OF ENLISTED PAYGRADES (SEA AND SHORE)
     BY QUARTER AND MONTH OF ROTATION.

F    MATRIX OF PROMOTED ENLISTEDS BY QUARTER

G    HOLDING VECTOR FOR XAVE BETWEEN POLICY RUNS

R    STRENGTH/BILLET DIFFERENTIAL MATRIX

SSQ  VECTOR OF MONTHLY SUMS OF MANNING LEVEL
     DIFFERENCES SQUARED

TQ   PREDICTED TOUR IN QUARTERS

X    CURRENT STRENGTH TO BILLET RATIO (MANNING-
     LEVEL)

XAVE VECTOR OF AVERAGE MANNING LEVELS OVER 72
     MONTHS OF ROTATION

XMAX VECTOR OF MAX MANNING LEVELS DURING 72 MONTHS
     OF ROTATION

XMIN VECTOR OF MIN MANNING LEVELS DURING 72 MONTHS
     OF ROTATION

Z    MATRIX OF MANNING LEVELS (SIX YEAR RUN)
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MODEL OUTLINE
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MAIN PROGRAM MONITORS THE GENERAL SIMULATION KEEPING ORDER IN THE ROTATION PROCESS AND TABULATING THE STRENGTH DIFFERENTIALS AND MANNING LEVEL MATRICES.

SUBROUTINE INITL PERFORMS INITIAL UNCORRECTED AND CORRECTED PRO ASSIGNMENTS AND COMPUTES FIRST QUARTER INPUTS TO THE E-3 AND BELOW, SEA AND SHORE COMPOSITES, AND GENERATES BILLET AUGMENTATIONS FOR RUNS SO REQUIRING.

SUBROUTINE SPREAD USING CONTINUATION AND PROMOTION STATISTICS, THIS ROUTINE WILL SPREAD THE COMPOSITE ACROSS THE ASSIGNED NUMBER OF QUARTERS (PROS). FIRST QUARTER ROTATION IS SET UP TO BEGIN.

SUBROUTINE MONTR MONITORS THE ELIGIBILITY CRITERIA FOR ROTATION AND APPLIES EITHER UNIFORM OR MONTHLY DETAILING GUIDANCE.

SUBROUTINE ROTN PERFORMS MONTHLY ROTATION BETWEEN AND WITHIN THE COMPOSITES.

SUBROUTINE ATPRC PERFORMS QUARTERLY ATTRITION AND PROMOTION WITHIN THE COMPOSITES.

SUBROUTINE OUTPUT TABULATES MEASURES OF EFFECTIVENESS AND MANNING LEVEL CRITERIA FOR POLICY IN FORCE.

****
SIMULATION CRITERIA
****

THE MODEL DEALS WITH TWO BASIC CONCEPTS OF ROTATION MANAGEMENT IN THE CONTEXT OF A NOMINAL 3/3 TOUR ENVIRONMENT.

TO MAINTAIN CERTAIN MANNING LEVEL CRITERIA, THE TOUR LENGTHS MAY BE RELAXED FROM THE THREE YEAR POINT OR THE EXISTING BILLETS MAY BE AUGMENTED TO CREATE A DESIRED STRENGTH TO BILLET (MANNING LEVEL) RATIO.

ADDITIONALLY THE USE OF BOTH UNIFORM DETAILING ACROSS THE QUARTER AND A PROPORTIONAL DETAILING (DETAILING GUIDANCE) IS USED.

RUN	BILLETS	TOURS	DETAILING
1	EXISTING	36/36	UNIFORM
2	AUGMENTED	36/36	UNIFORM
3	EXISTING	MOD1	UNIFORM
4	EXISTING	MOD2	UNIFORM
5	AUGMENTED	MOD2	UNIFORM
6	EXISTING	MOD2	PROPORTIONAL

NOTE: MOD1 ALLOWS SHORE TOUR RELAXATION UP TO 30 MOS
MOD2 ALLOWS SHORE TOUR RELAXATION UP TO 24 MOS

```
*MAIN PROGRAM STARTS HERE

      REAL LABEL/'3/3 '/,LABE1/'MOD1'/,LABE2/'MOD2'/,
     CLABE3/'PROP'/
      REAL*8 TITLE(12),TITLX(12)
      COMMON D(12),F(12,36),C(12),R(12,4),P(12),X(12),B(12),
     CT(12),TQ(12),S(12),E(12,36),Z(12,72),CQ(12),SSQ(73),
     CA(72),RK(6),SSSQ(72),XMAX(13),XMIN(13),XAVE(13),G(12)
100   FORMAT (12F5.0)
110   FORMAT (12F5.4)
120   FORMAT (6A8)
130   FORMAT (6F10.5)
200   FORMAT('0',25X,6A8)
201   FORMAT('0',42X,' INPUT DATA ')
202   FORMAT ('0',15X,'SHORE   SEA',3X,'SHORE   SEA',
     C3X,'SHORE   SEA',3X,'SHORE   SEA',3X,'SHORE   SEA',
     C3X,'SHORE   SEA')
203   FORMAT (' ',15X,'E8-E9  E8-E9',3X' E7     E7  ',
     C3X,' E6     E6 ',3X,'  E5     E5',3X,'   E4     E4',
     C3X,' E1-E3  E1-E3')
210   FORMAT ('0','STRENGTH      ',12F7.0)
220   FORMAT ('0','BILLET        ',12F7.0)
230   FCRMAT ('0','TOUR MCS      ',12F7.0)
240   FORMAT('0','CONTINUATION ',12F7.4)
250   FCRMAT('0','PROMOTION    ',12F7.4)

*INPUT SECTION-READS IN FIVE VARIABLE STREAMS, HEADINGS,
   AND CONTROL VARIABLES.

      READ (5,100)S,B,T
      READ (5,110)C,P
      READ (5,120) TITLE,TITLX
      READ (5,130)RK
      WRITE(6,200)TITLX
      WRITE(6,201)
      WRITE(6,202)
      WRITE(6,203)
      WRITE(6,210)(S(I),I=1,12)
      WRITE(6,220)(B(I),I=1,12)
      WRITE(6,230)(T(I),I=1,12)
      WRITE(6,240)(C(I),I=1,12)
      WRITE(6,250)(P(I),I=1,12)

*INITIALIZE LOOP AND WORKING VARIABLES.

      MK=0
      IX=15547
      DO 300 I=1,12
      TQ(I)=0.
      R(I,3)=B(I)
      R(I,4)=B(I)
300   R(I,1)=S(I)

*START POLICY LOOP - SIX SEPARATE POLICIES.

400   MK=MK+1

*INITIALIZE REPETITION VARIABLES.

      REP=0.
      DO 310 I=1,12
      DO 310 J=1,72
310   Z(I,J)=0.
      DO 320 I=1,72
320   SSSQ(I)=0.

*START 20 REPETITION LOOP.

410   REP=REP+1
      CALL INITL(MK)
      CALL SPREAD(IX)
```

```
*START 72 MONTH ROTATION LOOP.

      DO 330 LP=1,72
      DUMMY=0.0
      DO 340 I=1,11,2
      SQ=(X(I)-X(I+1))**2
340   DUMMY=DUMMY+SQ
      SSQ(LP)=DUMMY
      IF(MOD(LP,3).NE.1)GO TO 420
      CALL MCNTR(MK,LP)

*CALL FOR MONTHLY ROTATICN.

 420  CALL ROTN (LP)
      IF(MOD(LP,3).NE.0)GO TO 330

*CALL FOR QUARTERLY ATTRITION AND PROMOTION.

      CALL ATPRO(IX)
330   CONTINUE
      DO 350 I=1,72
 350  SSSQ(I)=SSSQ(I)+SSQ(I)

*END 20 REPETITICN LOOP.

      IF(REP.LE.19.1)GO TO 410
      CALL OUTPUT(MK)
      IF(MOD(MK,3).EQ.2)GO TO 430

*CALCOMP PLOTTER SHOWS SUM OF SQUARED MANNING LEVEL
         DIFFERENCES BY MONTH FOR DESIGNATED POLICIES.

      IF(MK-3)500,510,520
 500  CALL DRAW(72,A,SSSQ,1,0,LABEL,TITLE,0,0,0,0,0,
     C0.8,8,0,LAST)
      GO TO 430
 510  CALL DRAW(72,A,SSSQ,2,0,LABE1,TITLE,0,0,0,0,0,
     C0.8,8,0,LAST)
      GO TO 430
 520  IF(MK.EQ.6)GO TO 530
      CALL DRAW(72,A,SSSQ,2,0,LABE2,TITLE,0,0,0,0,0,
     C0.8,8,0,LAST)
      GO TO 430
 530  CALL DRAW(72,A,SSSQ,3,0,LABE3,TITLE,0,0,0,0,0,
     C0.8,8,0,LAST)

*END POLICY LOOP.

 430  IF(MK.LE.5)GO TO 400
      END
```

```
      SUBROUTINE INITL(MK)
      COMMON D(12),F(12,36),C(12),R(12,4),P(12),X(12),B(12),
     CT(12),TQ(12),S(12),E(12,36),Z(12,72),CQ(12),SSQ(73),
     CA(72),RK(6),SSSQ(72),XMAX(13),XMIN(13),XAVE(13),G(12)
      DO 300 I=1,12
      CQ(I)=TQ(I)
      DO 300 J=1,36
      F(I,J)=0.
  300 E(I,J)=0.

*DETERMINE TOUR LENGTH FOR POLICY IN FORCE

      IF(MK.GE.3)GO TO 400
      DO 310 I=1,12
      TP=(T(I)+1.1)/3
  310 CQ(I)=AINT(TP)
  400 DO 320 I=1,12
  320 S(I)=R(I,1)

*MAKE BILLET AUGMENTATION FOR POLICY IN FORCE.

      IF(MOD(MK,3).NE.2)GO TO 410
      DO 330 I=1,11,2
      S(I)=R(I,1)
      S(I+1)=R(I+1,1)
      R(I,4)=R(I,3)*XAVE(I)/XAVE(I+1)
      R(I+1,4)=R(I+1,3)
  330 CONTINUE
      GO TO 420
  410 DO 340 I=1,12
      S(I)=R(I,1)
  340 R(I,4)=R(I,3)
  420 IF (MK.LE.2)GO TO 430
      IF(MK.GE.5)GO TO 430

*MAKE TOUR LENGTH RELAXATION FOR POLICY IN FORCE.

      IF(MK.NE.3)GO TO 440
      DO 350 I=1,12
  350 XAVE(I)=G(I)
  440 DO 360 I=1,11,2
      IF(XAVE(I).GT.XAVE(I+1))GO TO 450
      IF(RK(4).GT.0)GO TO 360
      IF((XAVE(I+1)-XAVE(I)).LT.RK(1))GO TO 360
      IF(T(I+1).LT.26)GO TO 360
      CQ(I+1)=CQ(I+1)+RK(4)
      GO TO 360
  450 IF (T(I).LT.26) GO TO 360
      IF(RK(4).LT.0)GO TO 360
      IF((XAVE(I)-XAVE(I+1)).LT.RK(1))GO TO 360
      CQ(I)=CQ(I)-RK(4)
  360 CONTINUE

*COMPUTE INITIAL MANNING LEVELS.

  430 DO 370 I=1,12
  370 X(I)=S(I)/R(I,4)
      RETURN
      END
```

```
      SUBROUTINE SPREAD(IX)
      COMMON D(12),F(12,36),C(12),R(12,4),P(12),X(12),B(12),
     CT(12),TQ(12),S(12),E(12,36),Z(12,72),CQ(12),SSQ(73),
     CA(72),RK(6),SSSQ(72),XMAX(13),XMIN(13),XAVE(13),G(12)

*SPREAD STRENGTHS ACROSS ASSIGNED TOUR LENGTHS
       UTILIZING PROMOTION AND ATTRITION STATISTICS.

      DO 300 I=1,12
      TEMP=S(I)/CQ(I)
      M=CQ(I)
      TEM=(1.-C(I))*TEMP
      IF(MOD(M,2).EQ.1)GO TO 400
      K=M/2
      DO 310 J=1,K
      L=M-J+1
      E(I,J)=TEMP-TEM*(M+1-2*J)/8
      F(I,J)=E(I,J)*P(I)*L/4
      IF(F(I,J).LT.E(I,J))GO TO 410
      F(I,J)=E(I,J)
  410 E(I,L)=TEMP+TEM*(M+1-2*J)/8
      F(I,L)=E(I,L)*P(I)*J/4
      IF(F(I,L).LT.E(I,L))GO TO 310
      F(I,L)=E(I,L)
  310 CONTINUE
      GO TO 300
  400 K=(M-1)/2
      E(I,K+1)=TEMP
      F(I,K+1)=TEMP*P(I)*(K+1)/4
      DO 320 J=1,K
      L=M-J+1
      E(I,J)=TEMP-TEM*(K+1-J)/4
      F(I,J)=E(I,J)*P(I)*L/4
      IF(F(I,J).LT.E(I,J))GO TO 420
      F(I,J)=E(I,J)
  420 E(I,L)=TEMP+TEM*(K+1-J)/4
      F(I,L)=E(I,L)*P(I)*J/4
      IF(F(I,L).LT.E(I,L))GO TO 320
      F(I,L)=E(I,L)
  320 CONTINUE
  300 CONTINUE

*APPLY MONTE CARLO UNIFORM VARIABILITY TO THE
       SPREAD.

      DO 330 I=1,12
      DO 340 J=4,36
      CALL RANDU(IX,IY,YFL)
      IX=IY
      TEMP=1.+RK(5)*(2*YFL-1.)
      E(I,40-J)=E(I,37-J)*TEMP
  340 F(I,40-J)=F(I,37-J)*TEMP

*CLEAR THE FIRST QUARTER OF THE ROTATION MATRIX.

      DO 330 J=1,3
      F(I,J)=0.
  330 E(I,J)=0.
      RETURN
      END
```

```
      SUBROUTINE MONTR (MK,LP)
      COMMON D(12),F(12,36),C(12),R(12,4),P(12),X(12),B(12),
     CT(12),TQ(12),S(12),E(12,36),Z(12,72),CQ(12),SSQ(73),
     CA(72),RK(6),SSSQ(72),XMAX(13),XMIN(13),XAVE(13),G(12)
      IF(MK.EQ.6)GO TO 400

*APPLY UNIFORM DETAILING POLICY.
 410  DO 300 I=1,12
      DO 310 J=1,3
      E(I,J)=E(I,4)/3
 310  F(I,J)=F(I,4)/3
      DO 300 J=4,35
      F(I,J)=F(I,J+1)
 300  E(I,J)=E(I,J+1)
      GO TO 420

*APPLY DETAILERS GUIDANCE POLICY.
 400  DO 320 I=1,11,2
      IF(X(I).GT.X(I+1))GO TO 430
      IF ((X(I+1)-X(I)).LE.RK(3))GO TO 410
      IF ((X(I+1)-X(I)).GT.RK(2))GO TO 440

*MODERATE SEA TOUR CONTRACTION

      E(I+1,1)=E(I+1,4)*2/3
      F(I+1,1)=F(I+1,4)*2/3
      E(I+1,2)=E(I+1,4)*1/3
      F(I+1,2)=F(I+1,4)*1/3
      E(I,2)=E(I,4)*1/3
      F(I,2)=F(I,4)*1/3
      E(I,3)=E(I,4)*2/3
      F(I,3)=F(I,4)*2/3
      GO TO 320

*EXTREME SEA TOUR CONTRACTION

 440  E(I,3)=E(I,4)
      F(I,3)=F(I,4)
      E(I+1,1)=E(I+1,4)
      F(I+1,1)=F(I+1,4)
      GO TO 320
 430  IF ((X(I)-X(I+1)).LE.RK(3))GO TO 410
      IF ((X(I)-X(I+1)).GT.RK(2))GO TO 450

*MODERATE SHORE TOUR CONTRACTION

      E(I,1)=E(I,4)*2/3
      F(I,1)=F(I,4)*2/3
      E(I,2)=E(I,4)*1/3
      F(I,2)=F(I,4)*1/3
      E(I+1,2)=E(I+1,4)*1/3
      F(I+1,2)=F(I+1,4)*1/3
      E(I+1,3)=E(I+1,4)*2/3
      F(I+1,3)=F(I+1,4)*2/3
      GO TO 320

*EXTREME SHORE TOUR CONTRACTION

 450  E(I+1,3)=E(I+1,4)
      F(I+1,3)=F(I+1,4)
      E(I,1)=E(I,4)
      F(I,1)=F(I,4)
 320  CONTINUE
      DO 330 I=1,12
      DO 330 J=4,35
      F(I,J)=F(I,J+1)
      E(I,J)=E(I,J+1)
 330  CONTINUE
 420  RETURN
      END
```

```
      SUBROUTINE ROTN(LP)
      COMMON D(12),F(12,36),C(12),R(12,4),P(12),X(12),B(12),
     CT(12),TO(12),S(12),E(12,36),Z(12,72),CQ(12),SSQ(73),
     CA(72),RK(6),SSSQ(72),XMAX(13),XMIN(13),XAVE(13),G(12)

*CONDUCT MONTHLY ROTATION

      N=CQ(1)+3
      E(1,N)=E(1,N)+E(2,1)
      N=CQ(2)+3
      E(2,N)=E(2,N)+E(1,1)
      DO 300 I=3,9,2
      N=CQ(I)+3
  300 E(I,N)=E(I,N)+F(I+3,1)+E(I+1,1)-F(I+1,1)
      DO 310 I=4,10,2
      N=CQ(I)+3
  310 E(I,N)=E(I,N)+F(I+1,1)+E(I-1,1)-F(I-1,1)
      N=CQ(11)+3
      E(11,N)=E(11,N)+E(12,1)-F(12,1)
      N=CQ(12)+3
      E(12,N)=E(12,N)+E(11,1)-F(11,1)
      DO 320 I=1,12
      E(I,1)=0.
      F(I,1)=0.
      S(I)=0.
      IF(MOD(LP,3)-1)400,410,420
  410 DO 330 J=1,2
      E(I,J)=E(I,J+1)
  330 F(I,J)=F(I,J+1)
      E(I,3)=0.
      F(I,3)=0.
      GO TO 400
  420 E(I,1)=E(I,2)
      F(I,1)=F(I,2)
      E(I,2)=0.
      F(I,2)=0.

*CHECK THE STRENGTH OF THE COMPOSITES.

  400 DO 340 J=1,35
  340 S(I)=S(I)+E(I,J)
  320 CONTINUE

*LOAD THE MANNING LEVEL MATRIX.

      DO 350 I=1,12
      X(I)=S(I)/R(I,4)
  350 Z(I,LP)=Z(I,LP)+X(I)
      IF(LP.GT.3)GO TO 430
      DO 360 I=11,12
      N=CQ(I)+2
      IF(MOD(LP,3)-1)440,450,460
  450 E(I,N)=E(I,N)/3
      GO TO 360
  460 E(I,N)=E(I,N)*2
      GO TO 360
  440 E(I,N)=E(I,N)*3/2
  360 CONTINUE
      IF(LP.LE.3)GO TO 470
  430 E(11,36)=E(11,36)/3
      E(12,36)=E(12,36)/3
      DO 370 I=11,12
      N=CQ(I)+2
  370 E(I,N)=E(I,N)+E(I,36)
  470 IF (MOD(LP,3).NE.1)GO TO 480
      IF(LP.EQ.1)GO TO 480
      DO 380 I=11,12
  380 E(I,36)=0.
  480 RETURN
      END
```

```
      SUBROUTINE ATPRO(IX)
      COMMON D(12),F(12,36),C(12),R(12,4),P(12),X(12),B(12),
     CT(12),TQ(12),S(12),E(12,36),Z(12,72),CQ(12),SSQ(73),
     CA(72),RK(6),SSSQ(72),XMAX(13),XMIN(13),XAVE(13),G(12)
*CONDUCT QUARTERLY ATTRITION.
      INPUT=0.
      DO 300 I=1,12
      R(I,2)=0.
      D(I)=(1.-C(I))/4
      DO 310 J=1,36
      E(I,J)=E(I,J)*(1.-D(I))
      F(I,J)=F(I,J)*(1.-D(I))
  310 R(I,2)=R(I,2)+E(I,J)
*NOMINAL INPUT IS THE SUM OF QUARTER'S ATTRITION.
      INPUT=INPUT+(R(I,1)-R(I,2))
  300 CONTINUE
*APPLY MONTE CARLO UNIFORM VARIABILITY TO THE INPUT.
      CALL RANDU(IX,IY,YFL)
      IX=IY
      INPUT=INPUT*(1.+RK(6)*(2*YFL-1.))
      E(11,36)=INPUT*(B(11)+B(9))/(B(9)+B(10)+B(11)+B(12))
      E(12,36)=INPUT*(B(12)+B(10))/(B(9)+B(10)+B(11)+B(12))
*CONDUCT QUARTERLY PROMOTION.
  410 DO 320 I=3,12
      DO 320 J=4,35
      F(I,J)=F(I,J)+(E(I,J)-F(I,J))*P(I)/4
      IF (F(I,J).LT.E(I,J)) GO TO 400
      F(I,J)=E(I,J)
  400 E(I,J)=E(I,J)-F(I,J)
      E(I-2,J)=E(I-2,J)+F(I,J)
      F(I,J)=0.
  320 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE OUTPUT(MK)
      COMMON D(12),F(12,36),C(12),R(12,4),P(12),X(12),B(12),
     CT(12),TQ(12),S(12),E(12,36),Z(12,72),CQ(12),SSQ(73),
     CA(72),RK(6),SSSQ(72),XMAX(13),XMIN(13),XAVE(13),G(12)
  200 FORMAT('0',37X,' UNIFORM DETAILING POLICY ')
  201 FORMAT('0',32X,' EXISTING BILLETS  3/3 TOUR POLICY ')
  202 FORMAT('0',32X,' AUGMENTED BILLETS  3/3 TOUR POLICY ')
  203 FORMAT('0',32X,' EXISTING BILLETS  MOD1 TOUR POLICY ')
  204 FORMAT('0',32X,' EXISTING BILLETS  MOD2 TOUR POLICY ')
  205 FORMAT('0',34X,' AUGMENTED BILLETS MOD2 TOUR POLICY')
  206 FORMAT('0',36X,'     DETAILING GUIDANCE POLICY ')
  207 FORMAT ('0',15X,'SHORE    SEA',3X,'SHORE    SEA',
     C3X,'SHORE    SEA',3X,'SHORE    SEA',3X,'SHORE    SEA',
     C3X,'SHORE    SEA')
  208 FORMAT (' ',15X,'E8-E9  E8-E9',3X' E7     E7  ',
     C3X,' E6     E6 ',3X,'  E5     E5',3X,'   E4     E4',
     C3X,' E1-E3  E1-E3')
  210 FORMAT ('0','BILLET         ',12F7.0)
  211 FORMAT (' ','BILLET DIFF    ',12F7.0)
  212 FORMAT (' ','CORRECTED PRQ',12F7.0)
  213 FORMAT (' ','MAX MAN LEVEL',12F7.4)
  214 FORMAT (' ','MIN MAN LEVEL',12F7.4)
  215 FORMAT (' ','AVE MAN LEVEL',12F7.4)
  216 FORMAT ('0','SUMSQ ML DIFF',12F8.1)
  217 FORMAT ('0','SUM OF SUMSQ ML DIFF  ',F8.1)
      XMAX(13)=0.
      XMIN(13)=0.
      XAVE(13)=0.
*COMPUTE BILLET DIFFERENCES.
      DO 300 I=1,12
      TQ(I)=R(I,4)-R(I,3)
*COMPUTE AVERAGE MAXIMUM AND MINIMUM MANNING LEVELS.
      AVE=0.
      XMIN(I)=999999.
      XMAX(I)=-99999.
      DO 430 J=1,72
      IF(Z(I,J)-XMIN(I))400,410,410
  400 XMIN(I)=Z(I,J)
  410 IF(Z(I,J)-XMAX(I))430,430,420
  420 XMAX(I)=Z(I,J)
  430 AVE=AVE+Z(I,J)
      XMIN(I)=XMIN(I)/20
      XMAX(I)=XMAX(I)/20
      XMAX(13)=XMAX(13)+XMAX(I)
      XMIN(13)=XMIN(13)+XMIN(I)
*COMPUTE GRAND COMPOSITE AVERAGE MANNING LEVEL.
      XAVE(I)=AVE/1440
  300 XAVE(13)=XAVE(13)+XAVE(I)
      XMAX(13)=XMAX(13)/12
      XMIN(13)=XMIN(13)/12
      XAVE(13)=XAVE(13)/12
      SSQ(73)=0.
      DO 320 I=1,72
      A(I)=I
      SSSQ(I)=SSSQ(I)/20
*SUM THE SUM OF MANNING LEVEL DIFFERENCES SQUARED.
  320 SSQ(73)=SSQ(73)+SSSQ(I)
      IF(MK-2)441,442,443
  441 WRITE(6,200)
      WRITE(6,201)
      GO TO 444
```

```
 442 WRITE(6,202)
     GO TO 444

 443 IF(MK-4)451,452,453
 451 WRITE(6,203)
     GO TO 444
 452 WRITE(6,204)
     GO TO 444
 453 IF(MK.EQ.6)GO TO 454
     WRITE(6,205)
     GO TO 444
 454 WRITE(6,206)
     WRITE(6,204)
 444 WRITE(6,207)
     WRITE(6,208)
     WRITE(6,210)(R(I,4),I=1,12)
     WRITE(6,211)(TQ(I),I=1,12)
     WRITE (6,212)(CQ(I),I=1,12)
     WRITE (6,213)(XMAX(I),I=1,12)
     WRITE (6,214)(XMIN(I),I=1,12)
     WRITE (6,215)(XAVE(I),I=1,12)
     WRITE (6,216)(SSSQ(I),I=1,72)
     WRITE (6,217)SSQ(73)

*PLOT VALUES OF MAX, MIN AND AVERAGE MANNING LEVELS
         BY COMPOSITE

     CALL PLOTP(A,XMAX,-12,1)
     CALL PLOTP(A,XAVE,-12,2)
     CALL PLOTP(A,XMIN,-12,3)
     DO 330 I=1,12
 330 TQ(I)=CQ(I)
     IF(MK.NE.1)GO TO 460

*RETAIN AVERAGE MANNING LEVELS FOR FUTURE POLICIES.

     DO 340 I=1,12
 340 G(I)=XAVE(I)
 460 RETURN
     END
```

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3. ABSTRACT

The Enlisted Sea/Shore Rotation Model presents a methodology for the orderly reassignment of U. S. Navy enlisted personnel between the sea and shore communities. The model is flexible enough to evaluate a number of rotation policy operations within the context of published constraints on tour lengths and manning levels.

The primary objective is to propose alternate methods for sea/shore rotation management based on fixed tour lengths which will reduce the uncertainty of a rotation date to the individual. This was accomplished by assigning a firm projected rotation quarter (PRQ), and then modifying it to a specific month of rotation (MOR) within the PRQ, by notification, nine months prior to rotation.

Auxiliary solutions were also evaluated which augmented the present billet structure to achieve specified manning criteria.

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